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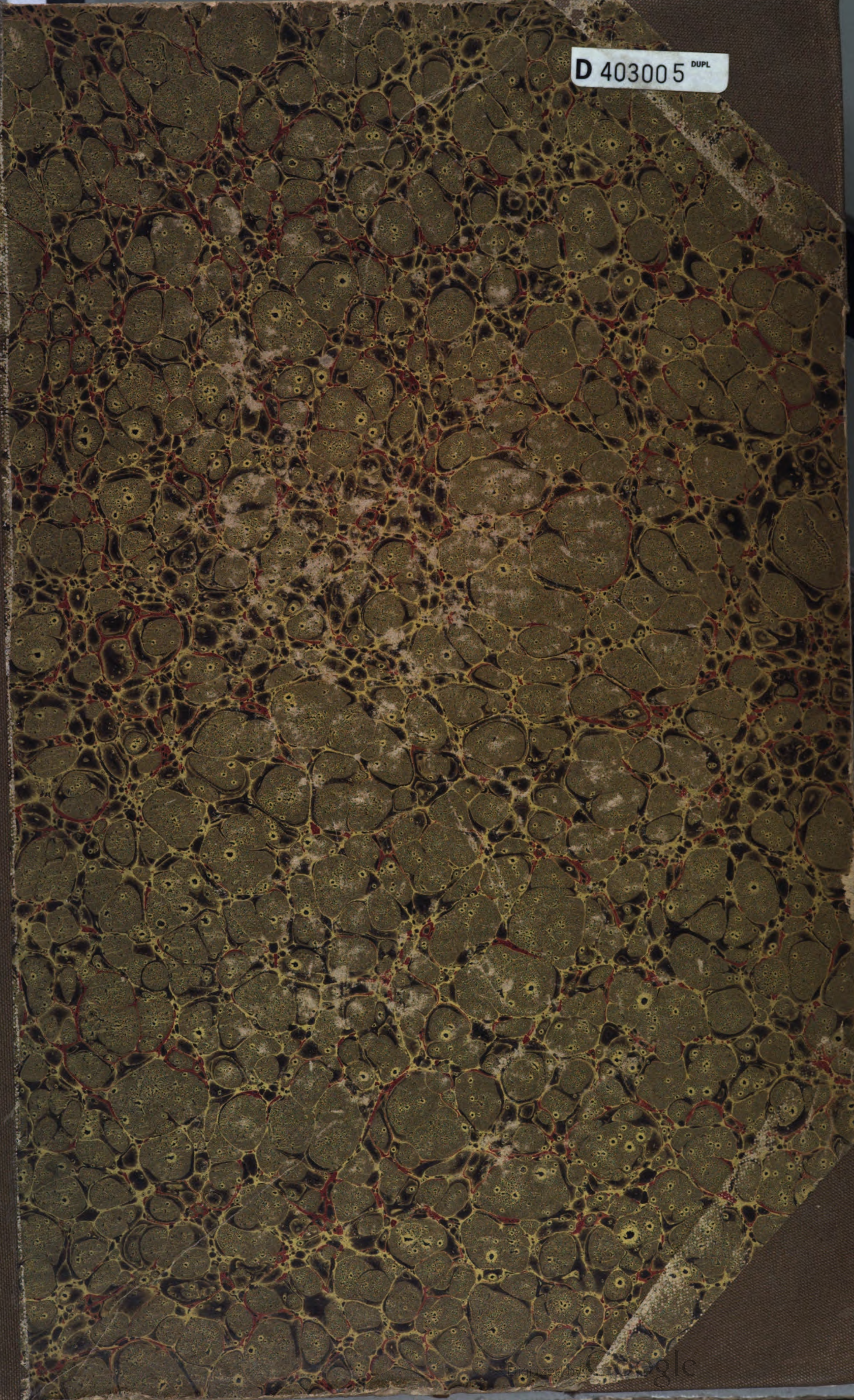

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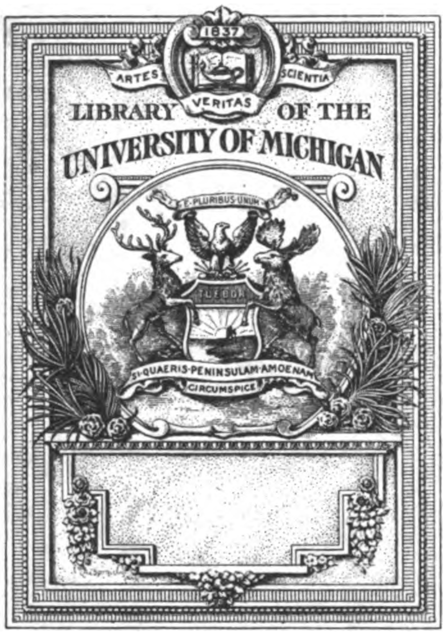
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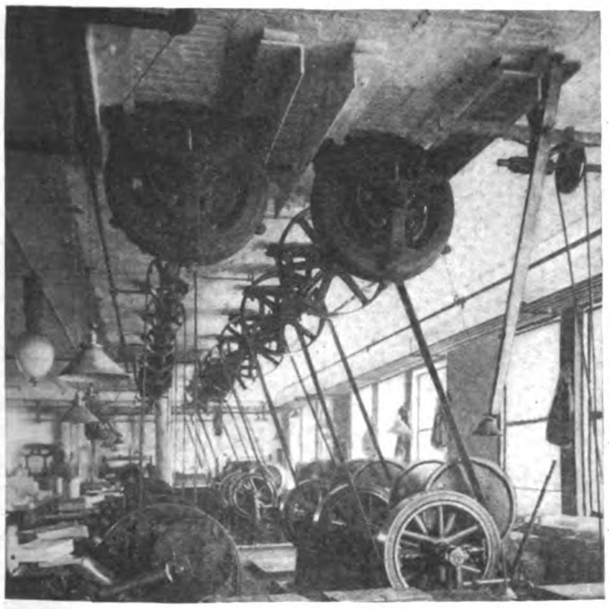
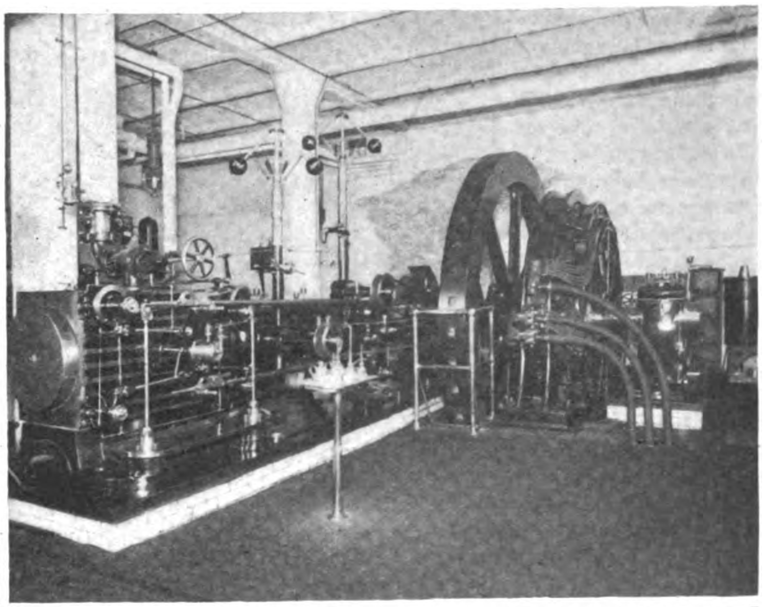
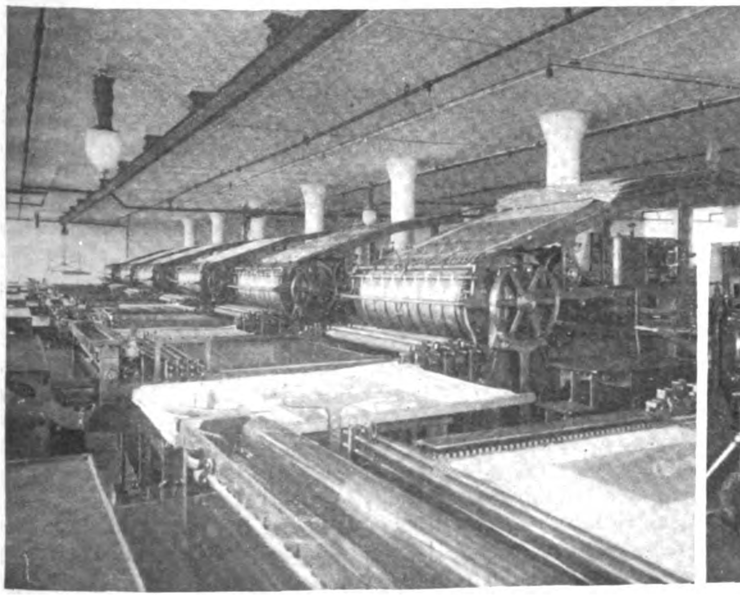
THE ELECTRICAL PLANT OF THE AMERICAN LITHOGRAPHIC COMPANY.

THE American Lithographic Company was formed in 1892, as a consolidation of ten of the largest lithographic companies in the East, turning out a large portion of the total product in this country. These concerns were doing business in nine different establishments in New York City, Philadelphia and Buffalo, with as many separate printing establishments, each operated by its own power plant. As the object of the consolidation of these companies was the reduction to be secured in manufacturing cost by the concentration of the business in one large establishment and shop, this latter was one of the first considerations, although on account of the magnitude of the project and of the diversified interests involved, it was not until the early part of 1896 that the actual construction of the new building was commenced.

With nine different shops turning out product, besides the large cost of management, each separate shop had its own steam plant, or purchased steam power from the owners of the building, and in addition paid for its gas or electric light. A number of the shops were equipped with expensive systems of belt and shafting transmission, which, while they were well designed for the original work, had, by means of continued extensions and alterations, become complicated and inefficient systems of power transmission. The steam apparatus used in some of the







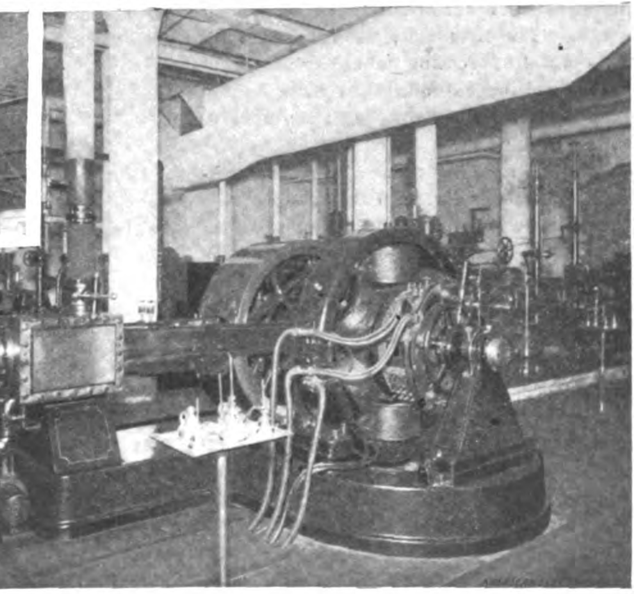


FIG. 1.—CEILING MOTORS DRIVING EMBOSSERS.

FIG. 2.—CORLISS-ENGINE UNIT.

FIG. 3.—MOTOR-DRIVEN LITHOGRAPHIC PRESSES.

FIG. 4.—HIGH-SPEED ENGINE UNIT.

MOTORS AND GENERATORS.

branches was also open to criticism as being inefficient and antiquated, and the labor employed for operating these various steam plants was of a much poorer quality than could be obtained for one large plant.

From the same causes and from the large amount of counter-shafting used, the lighting of these old establishments was not of the best quality. In addition, the item of insurance on the various buildings occupied was a large one, as most of them were in no sense fire-proof, the floors being cut up by belt-ways, elevator-shafts, stair-ways, etc. There was also a large amount of time lost in the transferring of work between the various branches.

The special work done by the company consists of lithography, comprising advertisements of high class, calenders, advertising specialties, photographic reproductions, cigarette pictures, cigar labels, newspaper supplements, etc.; letter-press work, comprising job printing and periodical printing; color printing; gilding; combination of lithographic and type press-work; advertising specialties; and the periodical *Truth*.

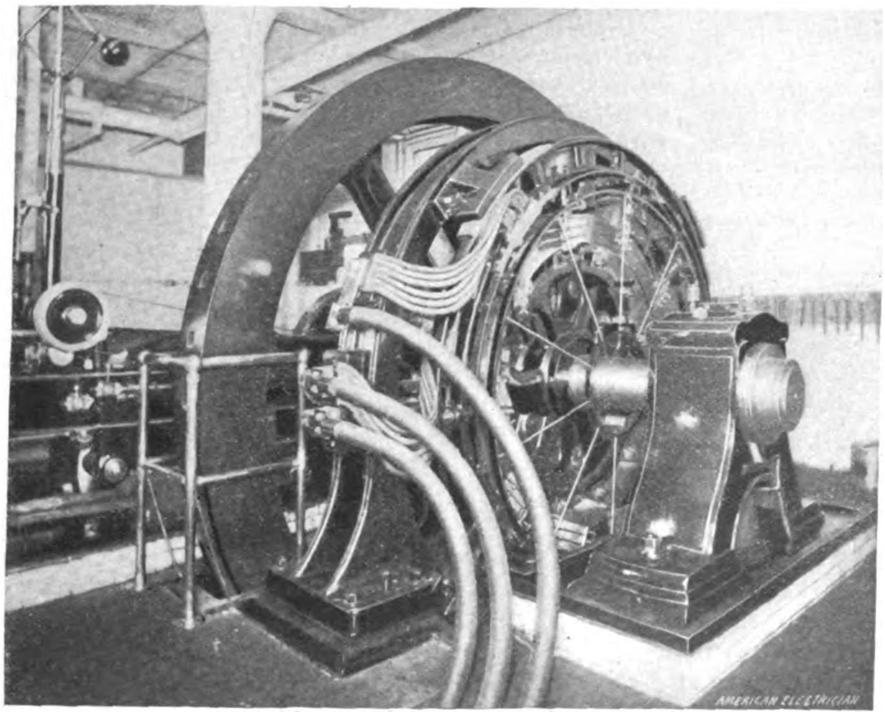


FIG. 5.—SMOOTH-BODY GENERATOR.

NEW BUILDING.

The new building of the company is located on the southwest corner of Fourth Avenue and Nineteenth Street, occupying a frontage of 131 ft. on Fourth Avenue and 200 ft. on Nineteenth Street. It comprises a basement, thirteen stories and a roof house.

The construction is entirely fire-proof throughout, consisting of steel girders and beams, iron columns and brick walls, the floors being tile arches filled in with cinder concrete with asphalt surface. The iron-work is covered with terra-cotta fire-proofing wherever exposed. The foundations extend to bed rock, a large amount of blasting having been required to obtain cellar room.

For safety and insurance against fire risk, a heavy fire wall divides each floor of the building into two parts, so that for practical purposes the building is in two sections, which will be referred to as the east wing and the west wing. Fig. 10 shows the floor plan of the building. For the same consideration of fire risk the stair-ways and elevator-shafts have been separated from the remainder of the building by fire walls, the fire walls however, being pierced at each floor by three doors. In the rear of the building is a light shaft 43 ft. × 80 ft., which, on the ground floor, forms a court-yard for the landing of freight received through a drive-way from Fourth Avenue.

The iron and steel structure of the building is of especially heavy design both to sustain the storage of heavy lithographic stones and boxes of paper on the third, fourth and fifth floors, and to prevent the vibration due to the large presses and machinery above.

The arrangement of the various floors is as follows:

Floor 13.	Artists and Provers.
" 12.	Stone Planers and Transfer Presses.
" 11.	Cutting and Embossing Machinery, Shipping Department and Storage of Stock.
" 10.	Folding and Finishing Machinery.
" 9.	Type Presses and Compositors.
" 8.	Lithographic Presses and Stock Storage.
" 7.	Lithographic Presses.
" 6.	" "
" 5.	Storage of Stock.
" 4.	Storage of Labels.
" 3.	Offices of Company and Storage of Lithographic Stones.
" 2.	Offices of Company and Art Gallery.
" 1.	Rented for Stores.
Basement.	Power Plant, Machine Shop and Store Cellars.

The first and second floors have the walls plastered, and are finished in hard woods. In the remainder of the building, the ceilings and walls are unplastered, but are pointed with cement and are whitened with cold-water paint.

ADVANTAGES OF ELECTRIC-POWER TRANSMISSION IN LITHOGRAPHIC ESTABLISHMENTS.

From tests made at one of the old printing shops of the company, the loss of power in belting and shafting throughout the building when indicated was found to amount to 60 per cent. of the full power indicated by the engine when driving all the machinery loaded. In times of slack work, this transmission loss, which is practically constant, aggregated as much as 75 per cent. of the power developed by the engine. This condition may be taken as an average of that obtaining at the other establishments. The cost of maintenance of belts and shafting was also a considerable item, with the annoyance and expense of delays from stoppage. In a lithographic establishment, the subdivision of the working machines into a number of small units necessitates the use of much counter-shafting and belting, which are especially objectionable on account of the dirt created and the obstruction of light. Good light is needed for the nice distinctions of registry and color, and dust is fatal to fine work.

Besides increased efficiency, there are many incidental advantages derived from the use of an electric-power transmission plant in a large manufacturing building. In general, the building can be laid out to greater advantage; in this case it was possible without the sacrifice of efficiency, to construct a manufacturing building in an expensive business section of the city, using the lower floors of the building for stores, offices and storage, and the upper floors for the power machinery. The flexibility of the system and the ease of control from the central engine room of any section of machinery or lights, also recommend it. The manufacturing machinery can be laid out to suit manufacturing conditions, and is not dependent on the limitations of line shafting and belts. Absolute protection from fire is guaranteed by obviating the necessity for holes in walls and floors for beltways. The electricity for lighting the building is generated from the same machines that furnish electric power, and consequently larger generators can be used, thereby securing higher efficiency. For one central power plant, a higher grade of engineers and electricians can be afforded, who will operate the machinery to better advantage. The evenness of power and speed of machinery driven by electric motor is another important feature. With conductors of proper proportions, a sudden demand for power by the working machine is instantly responded to by an additional supply of electric current from the generator. The smooth running due to this cause enables many of the machines to be operated at a higher speed than with a belt drive, thus increasing their output for the same labor cost.

Largely on account of the foregoing considerations, it was decided to install in the new building of the company an electric-power transmission plant, the electric power being generated from a central steam plant in the basement and transmitted through a system of conductors to each floor, to the electric motors driving the various machines. It was furthermore decided to equip each of the lithographic and large type presses with a separate motor direct connected to the main driving shaft of the press, and controlling it independently. This equipment with individual motors was also to be adopted for other special machines. For rows of small machines, such as cutters, embossers, die cutters, job presses, stone planers, transfer presses, etc., it was decided as more economical to operate these in groups of four or five machines belted to a short line shaft which is driven by a motor suspended from the ceiling and direct coupled to it. In this class of machinery there is no advantage to be gained by independent control. It was considered advisable not to install motors smaller than 2 HP on account of their relatively low efficiency, high first cost per HP and greater cost of repairs by reason of the larger number of units used. Electric elevators were adopted on account of their economy of operation, and ease of control.

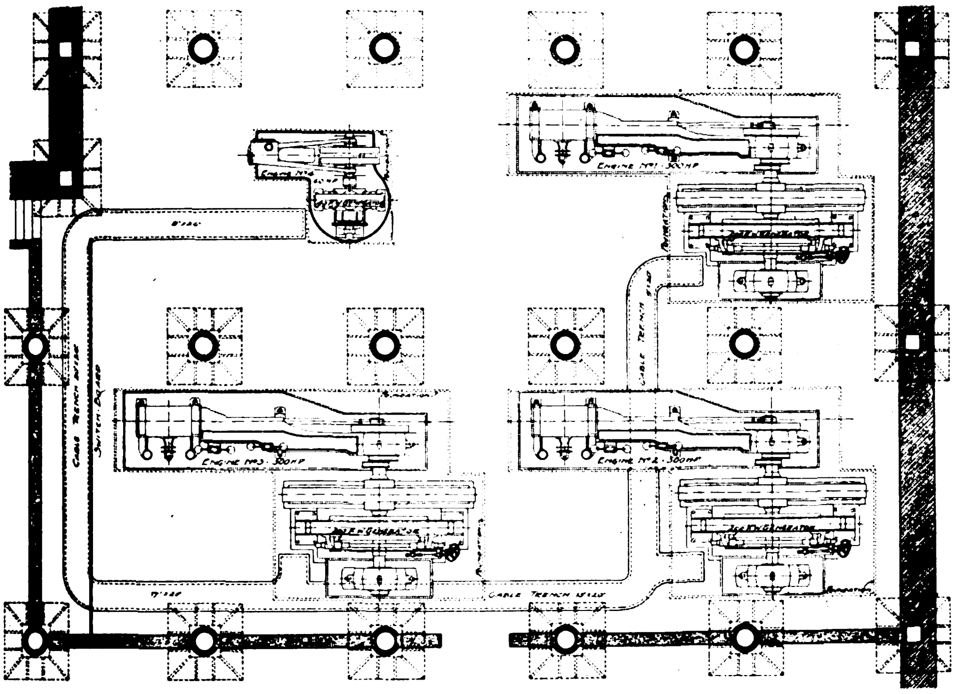


FIG. 6.—PLAN OF ENGINE ROOM.

With a few exceptions, due to excessive speed conditions, the entire equipment of motors is direct connected, either to the main driving shaft of the machine or to the ceiling shaft, thus obviating the use of belts or gears. The advantages gained by the good mechanical design of the equipment, the increased efficiency and longer life due to the slow speed, much more than outweigh the slightly increased cost.

THE GENERATING PLANT.

The engines and generators forming the electric generating plant are located in the basement of the west wing of the building, the boiler plant of five return tubular boilers being under the court yard and outside of the fire walls of the building.

Steam Engines.—The electric generating plant (Fig. 6) consists of two 20 in. × 36 in. non-condensing Watts-Campbell Corliss engines, running at 120 r. p. m., each direct connected to a 200-KW generator, and one 10 in. × 14 in. Straight Line engine running at 285 r. p. m. and direct connected to a 40-KW generator. Space is reserved in the engine room for a third 200-KW generator and direct-connected Corliss engine unit.

The Corliss engines (Fig. 2) are built extra heavy throughout to withstand the severe conditions of the service. The weight of each fly-wheel is 34,000 lbs., and running at the stated speed this has been found, in actual operation, to give a very close regulation. From tests made, it is found that the actual regulation secured is well within the limit specified, viz., 2 per cent. under a variation of load of from 40 per cent. overload to no load, this variation being obtained by tripping the main circuit-breaker. The speed at which these engines run is somewhat high for the Corliss type of engine, but on account of their special design, they fill the conditions of actual operation in a most satisfactory manner, the dash-pots and valves working most satisfactorily.

The cranks of these engines are of the balanced disk type, and the steam and exhaust valves are operated by separate eccentrics to increase the capacity of the engines for overloads. An additional safety governor has been attached to each engine. This is so constructed as to stop the engine by means of a butterfly valve in the steam admission pipe when the engine runs at more than 10 r. p. m. more than the normal speed, although the trip of this governor is subject to adjustment. As the engine room and foundations are below the level of the sewer, it was necessary to waterproof all openings in the foundation work, and accordingly heavy cast-iron, water-tight fly-wheel pits were furnished for the engines. Similarly, the field-magnet frames of the generators were enclosed in water-tight cast-iron pits.

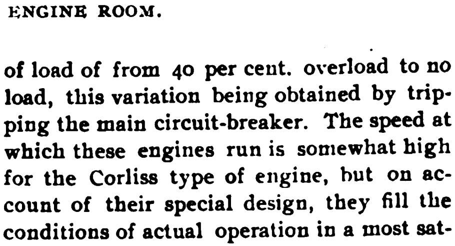


FIG. 7.—SECTION THROUGH CABLE TRENCH.

The Straight Line engine (Fig. 4) was installed to provide for the night-lighting load of the plant.

Generators.—The 200-KW generators used in this plant are of the General Electric "smooth-body" type (Fig. 5), such as are largely used throughout the country in Edison central stations, with the exception that these machines are compound wound instead of shunt wound, as is usual, and they are also provided with out-board bearings, an improvement upon the usual type of overhung armature used with this machine. The dimensions of these generators are as follows:

Number of poles, ten; speed, 120 r. p. m.; height, 99 ins.; floor space, 35 ins. × 146 ins.; diameter of shaft, 11 ins.; approximate weight of armature, 9600 lbs.; approximate weight of dynamo, 24,500 lbs. These machines are of the most mechanical construction, as they consist simply of the massive field-magnet frame and an armature which is so constructed that the windings are copper rods connected by end bars which form the surface of the commutator. The commutator, therefore, has as many segments as the armature has coils. Losses due to resistance in commutator leads and segments are eliminated, while the large number of segments reduces the volts per bar to a minimum, rendering the machines absolutely sparkless. It is possible that in the course of time if the commutator should wear down sufficiently, the armature can be turned end for end and the other side used for a commutator. The windings of straight copper bars with two joints for each convolution, render short circuits practically impossible. The brushes are of pressed-copper gauze and the brush holders are supported on studs which are held by a ring clamped between grooved brackets and bolted to the frame in such a manner that all the brushes can be shifted at once or raised simultaneously from the face of the commutator.

The small generator (Fig. 4) is of the usual General Electric "iron-clad" type with drum armature.

Foundations.—The foundations for engines and generators are shown in detail in Fig 20. The floor of the engine room rests on bed rock with the cast-iron foundation shoes, supporting the columns of the building, extending 3 ft. below the floor level into the bed rock. The foundations of the machinery are carried 3 ft. below this, or 6 ft. below the floor level, the rock having been picked out until a firm surface was encountered. The expansion bolts for anchoring the machinery were then sunk into bed rock and the excavation filled to a depth of 3 ft. with Dyckerhoff cement concrete in the proportions of 1, 2 and 3. With this as a base, the foundation was constructed of hard burned brick laid in Dyckerhoff cement mortar, the facing brick above the engine-room floor being enameled brick. An iron sole plate with elevated edge to receive oil or water drips from engine is used to cap the foundations. These foundations have proved to be of excellent design and construction, there being no perceptible vibration in the engines or in the adjoining columns of the building when the machines are in motion.

THE DISTRIBUTING PLANT.

The distributing plant will be considered in three parts: first, the connections between generators and switch-board, and the switch-board; second, the feeder system from switch-board to centers of distribution on each floor, including panel-boards; third, the branch circuits from panel-boards to outlets for lights and motors.

Generator Connections.—The connections between generators and switch-board are Habirshaw red-core, rubber-covered, insulated cables with lead armor, laid in trenches under the engine-room floor. The trenches are of the size shown on the engine-room plan (Fig. 6) and of construction as shown on detailed drawing (Fig. 7). The rock is excavated to the necessary depth and a 4-in. layer of concrete placed upon the bottom and sides, leaving a smooth inside surface. To this is applied a water-proofing of 1-in. felt and asphaltic cement, on which is laid 8 ins. of hydraulic cement concrete in the bottom, and 8 ins. of brick laid in hydraulic cement mortar on the sides. The object of these precautions is to obtain a thoroughly water-proof trench as there were encountered numerous springs of water in the location of the engine room, the floor level being below the level of the sewer.

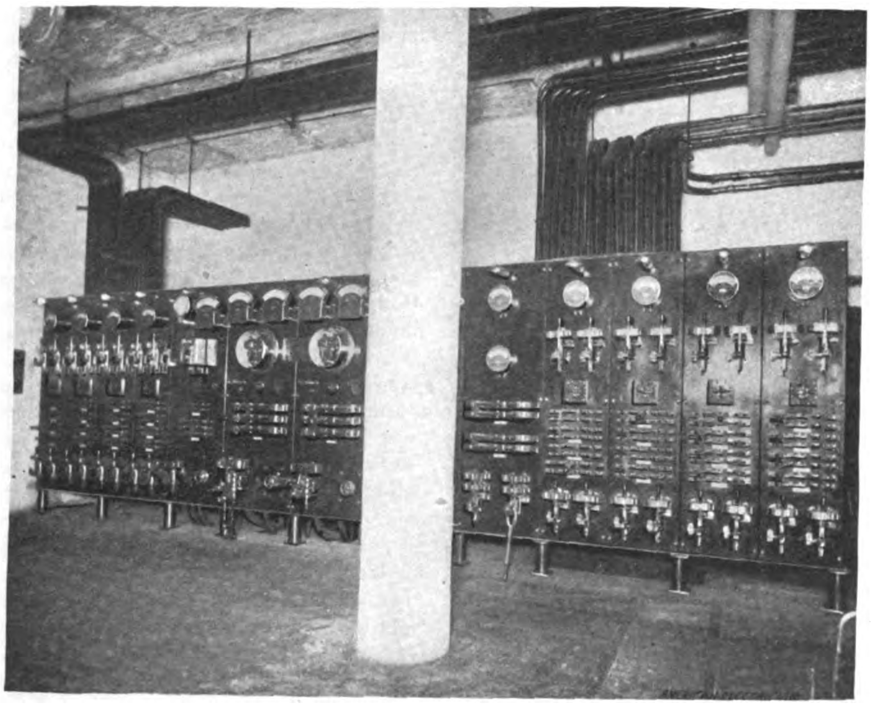


FIG. 8.—FRONT OF SWITCH-BOARD.

In the sides of the trenches as constructed, there are built cast-iron eyes for receiving the pins of the iron bridges which support the generator cables. The top of these bridges is covered with insulation to prevent injury to the lead armor of the cables. If it should be necessary to have access to the lower set of cables, the upper ones and the upper bridges can be readily removed. The trenches drain to one point where water can be removed, in case of its accidentally entering. Cast-iron plates, in sections, are used to cover the trenches, fitting into cast-iron frames, which are bedded in cement on top of the trench walls, and to which the asphalt floor of the engine room is joined.

The generator connections to the 200-KW generators are of 3,100,000 cm. section. These are so designed that under full load, the loss between generators and bus bars is not more than one-half volt. The equalizer connections are of the same size as the other cables. The generator connections to the 40-KW generators are 375,000 cm. in size. In order to secure the proper contact surface where the large generator cables join the terminals at the generators and at the switchboard, special heavy connecting clamps are used. Where the cables extend above the surface of the engine.room floor at the generators and switch-board, they are served with wrapping of hemp rope to protect the lead armor.

Switch-board.—The switch-board for this plant, as shown in Figs. 8 and 9, is 28 ft. 10 ins. long, 7 ft. 6 ins. high and is supported on pedestals 7 ins. above the floor of the engine room. The frame-work of the board is constructed of angle and T-iron shapes, firmly bolted together and securely braced from the wall in the rear. The supports from the floor are heavy ornamental brass castings. The board itself is of polished black enameled slate 2 ins. thick. The switch-board is divided into three general sections, the generator section being in the middle, the lighting section on one side and the power section on the other. Each section is divided into a number of panels, each panel being of the same size, but entirely separate and distinct from all of the others, so as readily to permit of future extension upon the same symmetrical arrangement. The generator section consists of four panels of equal sizes, one for each of the three generators now installed, and one for future use. A generator and a feeder panel are shown in section in Figs. 23 and 24.

Two independent sets of bus-bars extend the full length of the board, and, as all generator and feeder switches are double-throw, this arrangement allows two combinations of any generator and any circuit. In addition, the bus-bars are parted between the two center generator panels and provided with clamp connections, so as to afford still further subdivision of the plant if desired. At the top of the board behind the feeder panels are bolted iron spacing plates, to which the ends of the armored conduits for feeders are fastened. As shown in the photograph of the back of the board (Fig. 9), all of the flexible connections are enclosed in flexible conduit. All of the copper-bar and clamp connections are of sufficient size to secure the proper contact surface to correspond to the carrying capacity of the connections.

In addition to the usual apparatus, upon each one of the generator panels, there is mounted a Thomson recording wattmeter and a Cutter automatic circuit-breaker, besides the regular fuse connections. A careful daily record is kept of the amount of current generated by each machine. The generator panels are provided with Weston voltmeters and ammeters, together with a Bristol recording voltmeter. Carpenter enamel rheostats are used.

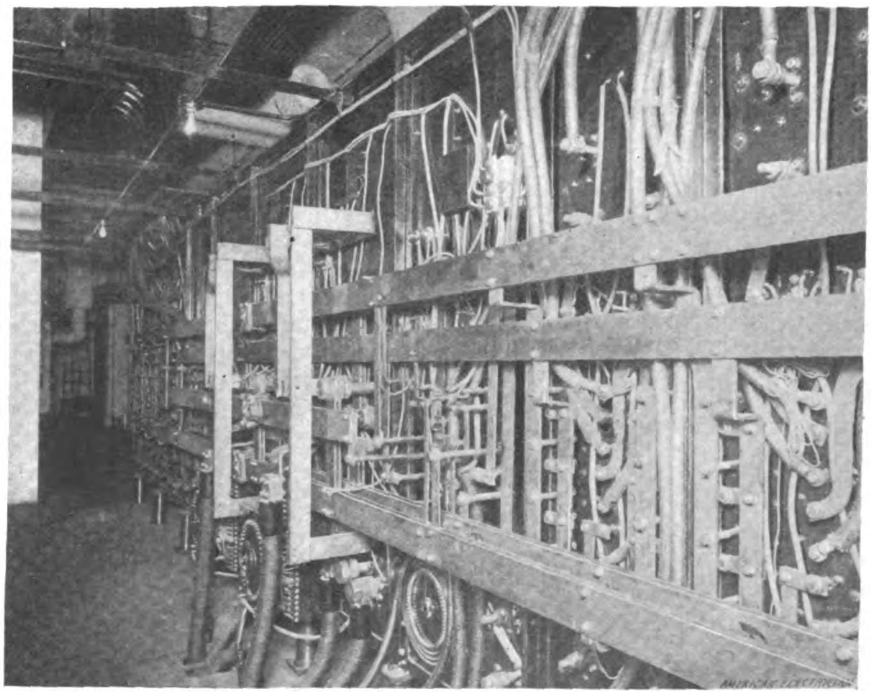


FIG. 9.—REAR OF SWITCH-BOARD.

There are 16 lighting feeder circuits and 16 power feeder circuits terminating at switches at the switch-board, together with 2 elevator feeder circuits. Each feeder panel contains the switches, circuit-breakers, etc., for controlling four feeder circuits. A Cutter automatic circuit-breaker protects each feeder circuit. In order to obviate a multiplicity of ammeters on this board, special knife-blade ammeter switches were designed for connecting in turn the leads from each of the four feeder circuits of one panel to one ammeter. The ammeters were calibrated in connection with these special switches, so as to insure accuracy.

Feeder System.—The general arrangement of the feeder system for light and power, is such that the east wing and the west wing of the building have each an entirely separate set of conductors from the switch-board; in fact, the two wiring systems are so completely distinct that they could be in two separate buildings. In the event, therefore, of one wing of the building being disabled in any manner, the remaining portion could be operated entirely independent of the crippled part. In addition the feeders for lighting and for power are entirely separate and distinct. This is shown in the illustration of the switch-board (Fig. 8), in which four separate runs of steel conduit can be seen, consisting of power feeders and lighting feeders for each wing of the building.

On each floor except the first for each wing, there is located a center of distribution for the floor, which consists of a slate panel-board, with switches for lighting and power branch circuits. All of the wiring throughout the building, from the switch-board to the outlets for lights and motors, is run in steel or iron-armored interior conduit, one conductor per tube. The cable and wire used is provided with Habirshaw red-core rubber-covered insulation. Wire larger than No. 6 B. & S. is stranded.

For each wing there was provided during the construction of the building, as shown in Fig. 10, a vertical recess in the center wall of each wing, to be used as a wire-way for the feeders to the various floors. This recess varies from 4 ins. to 8 ins. in depth, and is 5 ft. wide, the dimensions being such as to allow of about 50 per cent. reserve space after all the feeders for present use have been installed. The front of these wire-ways is provided with an iron frame-work on each floor, bolted to the beams of the building and covered with crimped galvanized iron. Fig. 21 shows the construction of the recess, framing and covering for one floor. The crimped-iron covering is fastened to the iron frame-work by screws, so that it is readily removable, should it be necessary to have access to the feeders to remove them or to make additions.

At a convenient distance from each floor in the center of the wire-way space, is placed the panel-board supplying the floor. This panel-board, which is shown in Fig. 21, is constructed of black enameled slate 1 in. thick, which is bolted to two light angle-irons, which in turn are secured to the iron frame-work supporting the wire-way covers. The panel-board is enclosed on all sides by slabs of slate, which project out to the crimped-iron covering, forming a box about 2 ft. 6 ins. wide, 4 ft. high and 4 ins. deep, in which are contained the small bus-bars, switches and fuses for controlling the power and lighting branch circuits for the floor. Supported by the iron framing are two doors which form the outside cover of the panel board. These doors have iron stiles 1 in. wide, with removable iron straps in which are screwed heavy plate-glass panes, which are bedded in rubber strips; each door being furnished with a Yale lock.

By this construction, the whole wiring system, from the switch-board to the centers of distribution, has been made entirely fire-proof and of the most permanent and mechanical construction, and at the same time all parts of it are readily accessible for repairs and additions. The lay-out for the feeder distribution is shown on the isometric sketch (Fig. 22), feeders for lighting being shown dotted, the power feeders by full lines. As shown, there is a separate power feeder for each wing of each floor upon which power machinery is used.

For lighting, there is a separate feeder in each wing for the first and second floors and above this for each two or three floors, as shown. A separate feeder is run in the elevator-shaft for lighting of elevator halls and stair-ways. There are no main centers of distribution on the first floor, this being the floor which is rented by the company for stores. There is a separate sub-feeder circuit for each store, running from the basement centers to small panel-boards placed in each store. Usually the store circuits are furnished with current from the Edison Illuminating Company's street mains by a service connection to special double-throw switches placed upon the basement panel

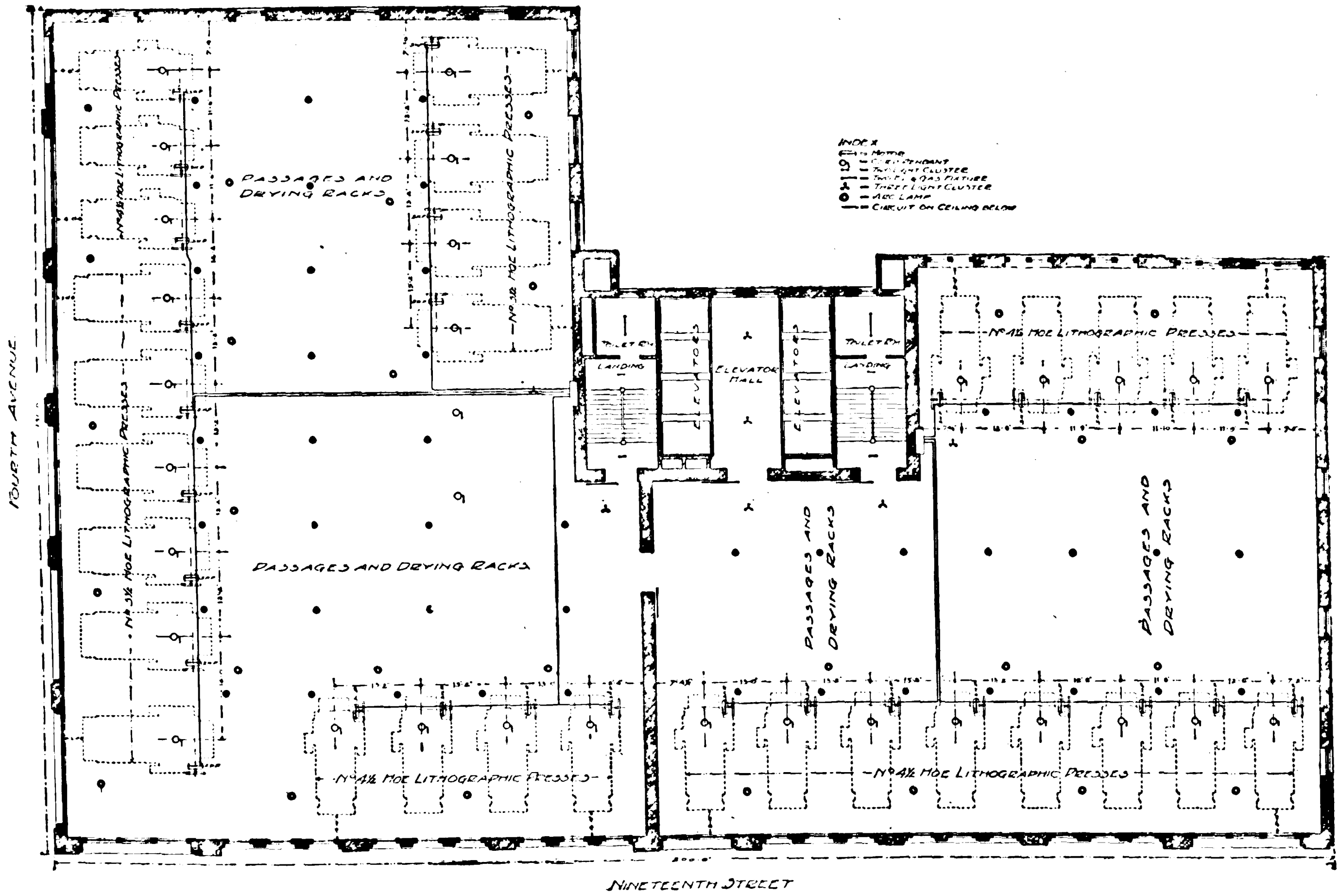
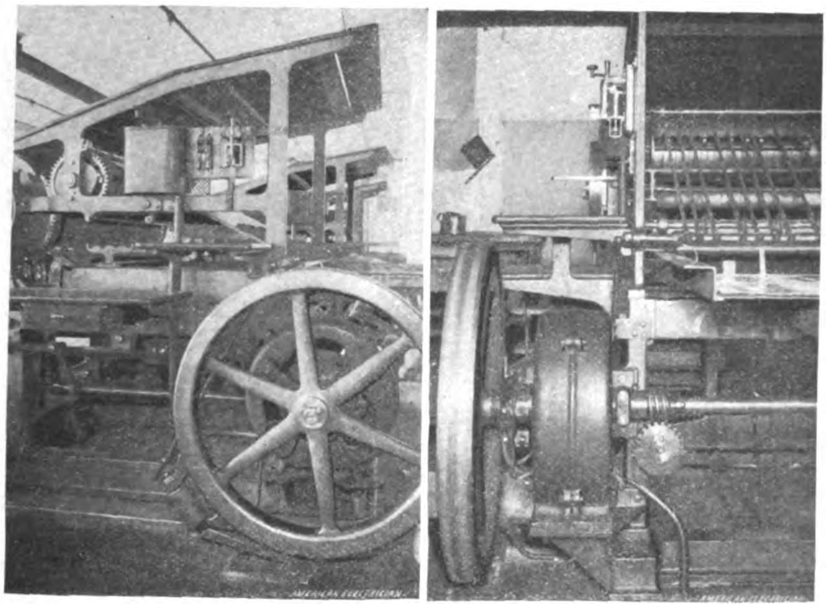

INDEX
= Motor
— Pendant
— Two Light Cluster
— Two Light & Gas Fixture
— Three Light Cluster
— Arc Lamp
— Circuit on Ceiling Below
Fourth Avenue
Nineteenth Street
Passages and Drying Racks
Passages and Drying Racks
Passages and Drying Racks
Passages and Drying Racks
No. 3½ Hoe Lithographic Presses
No. 3½ Hoe Lithographic Presses
No. 3½ Hoe Lithographic Presses
No. 4½ Hoe Lithographic Presses
No. 4½ Hoe Lithographic Presses
No. 4½ Hoe Lithographic Presses
Toilet
Toilet
Landing
Landing
Elevator
Elevator
Elevator Hall

FIG. 10.—PLAN OF TYPICAL PRESS FLOOR.

boards. By throwing these switches, the store circuits can by changed from Edison service to building service at any time, and the 3-wire system of the branch store circuits changed to the 2-wire system, used throughout the building.

The heavy runs of iron-armored interior conduit enclosing the feeders, from the switch-board to the wire-way recesses, are supported from the ceiling of the basement by special pipe hangers. For supporting the iron conduit and feeders in the vertical wire-way recesses, there are built into the brick-work, at the first, fourth and eighth floors, heavy cast-iron fire-stops which are drilled to accommodate the lines of conduit, the couplings of the conduit resting on the fire-stops. At the other floors, the fire-stops are of ¼-in. sheet-iron drilled with the necessary holes for conduit. The covering for wire-way recesses at the first and second floors, where the walls are plastered and finished, is constructed of metal lath, plastered, and made to conform with the surrounding finish.



FIGS. 11 AND 12.—SIDE AND END VIEWS OF LITHOGRAPHIC PRESS-MOTOR EQUIPMENT.

The lighting feeders, when fully loaded to the capacity of the plant now installed, are designed to have a loss of potential between the bus-bars of the switch-board and their respective centers of distribution, of not more than 3 volts; under the same conditions, the power feeders are designed for a loss of not more than 4 volts.

Branch Circuits.—As shown on the horizontal section of the wire-way recess in Fig. 21, the power and lighting feeders occupy the part of the wire-way which forms a recess in the wall, and the slate panel-board and branch circuit wiring for each floor occupy the part of the wire-way which extends out into the room. Each branch circuit on the panel-board is controlled by a double-pole knife-blade switch, the space between the panel-board and glass doors being deep enough to allow of switches being open or closed. In addition, on each panel-board there is left reserve space for the future installation of from 25 per cent. to 50 per cent. more branch circuits.

Referring again to Fig. 21 showing the wire-way construction, the connections for branch circuits from the panel-board to the steel conduit in the room are shown. Except on the first and second floors, where the ceilings and walls are plastered, the remainder of the branch wiring is run in exposed steel-armored conduit, which is suspended from the tile arches by means of small iron toggles. The floor construction of the building rendered it impossible to conceal these branch circuits. It was also considered desirable in a factory building to have all of the branch circuits readily accessible, and as all of the wiring construction is entirely protected by steel-armored conduit, the only possible objection to such construction is on the ground of appearance. At the point of entrance to the wire-way, the steel conduit on the ceiling is joined to a special multiple-corner insulating box supported by the iron frame-work of the wire-way. This special corner box is of cast-iron and made of such size as to permit of the future installation of about 50 per cent. more branch circuits, the holes for the entrance of these circuits being closed with small iron caps. In the wire-way recess, from this corner box to the panel-board, the branch circuit wiring is protected by flexible conduit.

For the power branch circuits, where the motors are placed on the floor, the branch circuits, instead of running to the ceiling of the room and dropping down to the motor, are run down through the wire-way from the panel-board to the ceiling corner box of the next room below, from which point they run on the ceiling to a position directly under the motor and then come up through the floor to the motor; the motor outlet box in this case being on the ceiling of the room below. Branch circuits to motors suspended on the ceiling run to outlet boxes on the ceiling located at the column nearest to the motor, the controlling apparatus for ceiling motors being placed on the nearest column or wall.

Outlet Boxes.—Special insulating iron outlet boxes are used for motor circuits, of sufficient size to include porcelain cut-outs of the required capacity. Runs of conduit for power branch wiring are shown in Fig. 15, which also shows the outlet boxes and the conduit to the controlling devices. The branch circuits for lights terminate in cast-iron insulating outlet boxes which, in the case of heavy fixtures and arc lamps, are supported by pipe hangers running up through the tiling and secured by washers. As it was, in many cases, impossible to arrange the lighting of the rooms until the machinery had been placed, the five-light outlet boxes on the upper floors are supplied with two branch side outlet openings for future extension of branch circuits, these, when not in use, being closed with iron caps. The one-light outlet boxes throughout the building are provided with special covers, the receptacle boxes have a socket bushed through the cover, and the pendant boxes having rubber bushings for the outlet of the flexible cord. There are about 2100 outlets for lights throughout the building and 150 outlets for motors.

Switch Control.—In addition to the switches controlling the branch lighting circuits upon the panel-boards, certain classes of lighting outlets are controlled independently. Upon the third and fourth floors, which are used for the storage of labels and lithographic stones in racks, the aisles between the racks are lighted by rows of incandescent lamps, each aisle being separately controlled by a Cutter flush switch with iron wall box fastened to the end of the rack, so that each row of lights is used only when the workman is searching for a particular label or stone. All 3- or 5-light ceiling outlets in the stores and offices are controlled by Cutter flush-switches.

THE MOTOR SYSTEM.

The motors used for driving the various classes of machinery in this building vary in size from to 2 to 35 HP. As it was the desire to make the entire equipment of the most permanent and mechanical design, slow-speed motors were adopted direct-connected to the machine or counter-shaft which they drive.

The equipment of the lithographic presses is as shown in Figs. 11, 12 and 26. The motors used for this work are of the series-wound, iron-clad type, relatively narrow so that they can be placed directly on the extension of the main driving-shaft of the press between the fly-wheel and the press frame. The mechanical design of these motors is such as to make them simple, strong and durable in every part and easily accessible for repairs, the general outline being neat, compact and symmetrical. The motors are supported upon heavy cast-iron brackets securely bolted to the frame of the press, and the upper part of the motor frame is also attached to the press by means of a heavy iron strap. In order to regulate more closely the variation of speed of these lithographic presses, extra heavy fly-wheels are used. A special electric brake, consisting of a solenoid magnet, acts upon the periphery of the fly-wheel.

The controlling apparatus for these equipments consists, as shown in the illustrations, of a main double-pole, knife-blade switch with fuses, a Cutter automatic circuit-breaker and a special cylinder controller enclosed in an iron case and operated by a short lever with pointer. Upon the lithographic press equipments, five speeds can be obtained, so that the output can be varied from 660 to 1140 impressions per hour. A motion of the controller lever automatically sets the electric brake, stopping the press as quickly as may be desired, and a movement to still another notch causes the press to reverse at a slow speed. The variation in speed is accomplished by commutating the field of the motor, which method, besides being efficient, obviates the necessity for using external resistance in the form of a rheostat.

The absolute control of the speed and movement of presses by means of the electric controller is considered by printers as one of the greatest improvements that have been made upon printing machinery in recent years, saving both time and annoyance over the old method of shifting belts, foot brakes and backing up by tugging on the fly-wheel. The wiring connections between the motor, the controller and the electric brake, are carefully insulated and neatly run in one line of iron-armored conduit, as shown in the illustrations, so that every part of these equipments is entirely protected from mechanical injury.

A view of one of the lithographic press rooms is shown in Fig. 3. In addition to the lithographic press equipments, there are a large number of other classes of machines, which are shown in the following list:

MOTOR EQUIPMENTS OF THE AMERICAN LITHOGRAPHIC COMPANY.

Motors.		HP.
93	Direct Connected to Presses	365.5
32	" Coupled to Shafting Driving Paper Cutters, Embossers, Job Presses, Stone Planers Die Cutters, Bronzers and Dusters, Stitching Machines, Roughing Machines, Calenders, Plating Machines, Knife Grinders Machine Tools, etc.	150.5
2	" Connected to Drying and Folding Machines	4.0
3	" Geared to Calenders, Burnishing and Sizing Machines	22.0
3	" Coupled to Ventilator Fan Shafts	10.0
8	" " Worm Gearing of Elevator Machines	295.0
Total.	Total HP	847.0

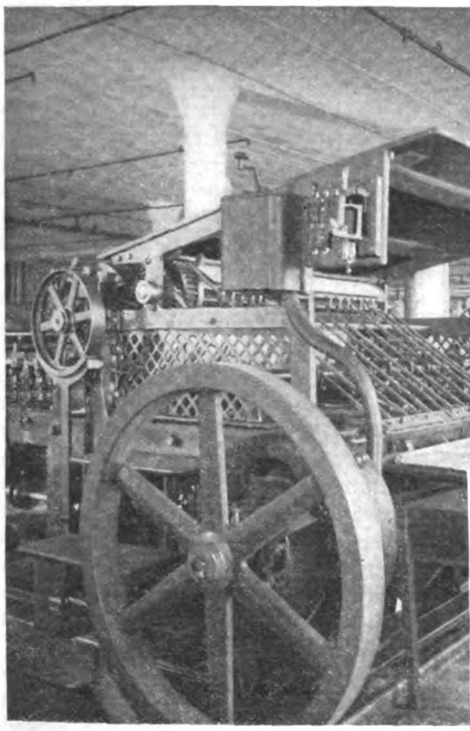


FIG. 13.—STOP-CYLINDER TYPE-PRESS MOTOR EQUIPMENTS.

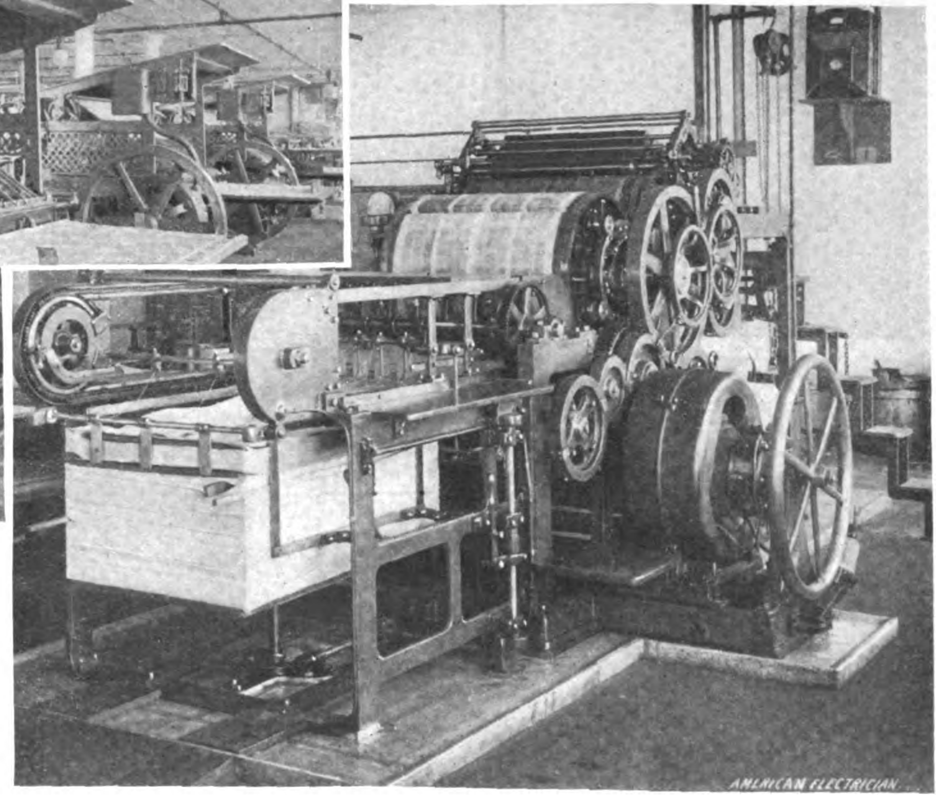


FIG. 14.—ROTARY-PERFECTING-PRESS MOTOR EQUIPMENT.

Three floors of the building are devoted to lithographic press-work and one floor to the typographic presses. The large type presses consist of two-revolution, stop-cylinder, rotary and perfecting presses of many sizes. These are driven by motors direct connected to the main driving shaft of the press and supported either by cast-iron brackets, as shown in Fig. 13, or by means of cast-iron pedestals resting upon the floor and bolted to the main press-frame (Fig. 14).

The controlling apparatus is in every case conveniently located with reference to the press feeder. The controllers are designed for obtaining the same number of variations in speed as with the lithographic presses, by means of commutated-field control, and also for obtaining reversal and electric braking. In the case of a rotary press, such as is shown in Fig. 14, the press can be stopped in addition to the movement of the controller, by means of several push buttons conveniently located at the delivery end of the press. These push buttons operate a secondary circuit, auxiliary circuit-breaker and electric brake, so that by pushing any button, the main circuit is opened and the electric brake applied.

The sizes of the type-press motor equipments vary from 2 to 10 HP with variations of speed to meet the actual operating conditions imposed by each different kind of equipment. The thirty-two small Gordon and Allen job presses are belted to short line shafts, which are driven by ceiling motors direct coupled to them.

The design and support of the ceiling motors are shown in Figs. 18 and 25. As the shafting to which they are coupled runs at moderate speed, varying from 100 to 500 r. p. m., the same type of slow-speed motor is in general employed. These motors are suspended from a frame-work of special channel and angle-iron shapes, which are secured to the steel girders and beams of the building by special beam clamps as shown, the position of the motor, vertically, being fixed by means of special distance blocks. Each motor has its own independent bearings, so that it has no dependence upon any of the shafting hangers, the motor shaft being coupled to the line shaft by means of a special adjusting Brown coupling. All of the ceiling motors are shunt wound, and with but few exceptions run at one speed without reverse. The controlling apparatus of these motors is shown in Fig. 15. It consists of a double-pole knife-blade main switch and fuse cut-out, a Cutter automatic circuit-breaker and a Cutler-Hammer automatic underload starting box. The wiring, as shown, between ceiling cut-out boxes and controlling apparatus, and between controlling apparatus and motor, is all in steel-armored interior conduit.

As shown in the accompanying list, almost all of the miscellaneous and finishing machinery used in this building are arranged in groups of several machines belted to a line shaft, which is driven by a ceiling motor direct-coupled to it. For machines of this kind, the operation of which is intermittent in character, such as cutting machines, embossing machines, stone planers, die-cutting machines, bronzing and dusting machines, stitching machines, stone grinders, roughing machines, plating, calendering and burnishing machines, it is more economical and satisfactory to operate them in groups with motors averaging 5 HP than to drive each machine by a small direct-connected or geared motor; the first cost is considerably less and the operating efficiency is higher. There is generally no need for separate and independent control of each one of these machines, as while it is in operation there is a heavy fly-wheel in continuous movement, the starting device of the machines throwing into action the clutch, which takes up the stored momentum and gives an even start, so that it is a disadvantage to stop and start the electric motor whenever the application of power is necessary.

In cases of some special finishing machinery, such as sizing, calendering and burnishing machines, it is necessary to obtain an extremely slow speed by means of spur gearing or special worm gearing between motors and main driving shafts.

Fig. 16 shows a number of ceiling motors direct-coupled to lines of shafting driving paper cutters, and Fig. 1 shows ceiling equipments operating lines of embossing machines. Fig. 17 shows a special ceiling motor coupled to a counter-shaft driving a heavy plating machine. In machines of this class and in calendering and burnishing machines, the character of the work turned out by the equipments driven by electric motors is found to be more satisfactory than with the belt drive on account of the more even application of power. With almost all of printing and finishing machinery it is found that a larger amount of product can be turned out from electrically driving machines, due to the more even application of power. The motors used for driving the machinery above described are of the Lundell slow-speed, multipolar type.

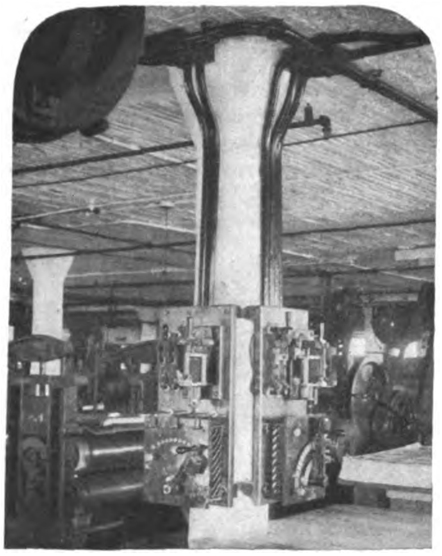


FIG. 15.—CONTROLLING DEVICES FOR CEILING-MOTOR EQUIPMENTS.

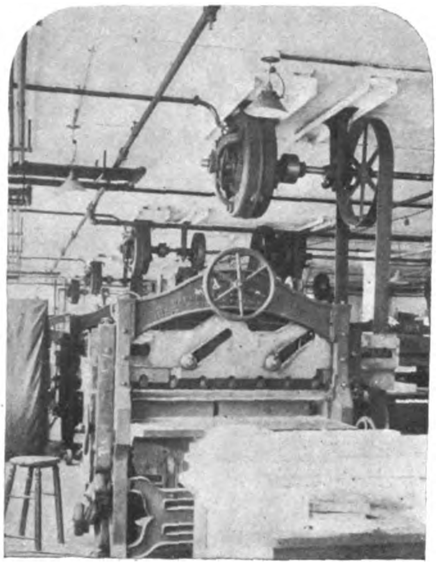


FIG. 16.—CEILING MOTORS DRIVING PAPER CUTTERS.

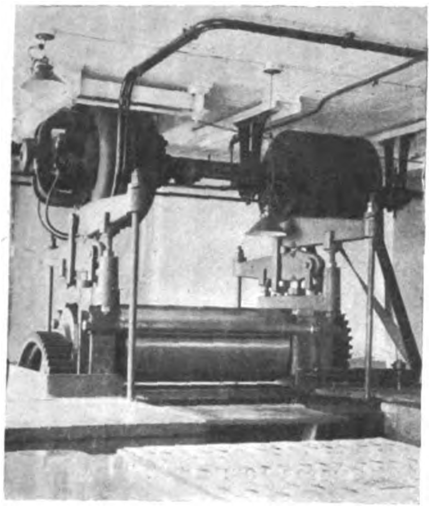


FIG. 17.—CEILING MOTOR DRIVING PLATING MACHINE.

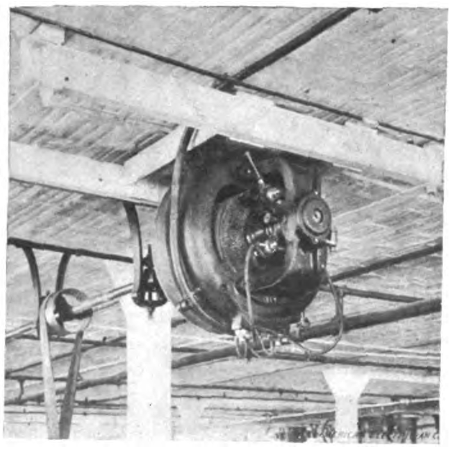


FIG. 18.—CEILING-MOTOR SUSPENSION.

Elevator Motors.—The elevator machinery consists of two banks of four elevators, or eight in all; two of these being passenger elevators. Each freight elevator is designed for a regular load of 4000 lbs. at a speed of 150 ft. per minute. These machines, however, have been tested with a total load of over 7000 lbs. The passenger elevators are each capable of lifting 3000 lbs. at a speed of 250 ft. per minute. The elevator machines are of the drum type with Keystone motors connected to the hoisting drums by means of duplex worm and spur gearing. In addition to the safety devices ordinarily employed, each elevator motor is protected by a Cutter automatic underload and overload circuit breaker.

Safety Appliances.—The protection against overload of all generators and motors in the building has been carefully provided for by a number of safety devices, as shown. Each generator is protected by fuses and circuit-breaker; each feeder circuit on the switchboard is also protected by fuses and circuit-breaker, and each branch circuit on the panel-boards is protected by fuses. Each motor is protected at the outlet box by fuse cut-out and, in addition, on the controller-board by fuses and automatic circuit-breaker. In the case of shunt motors, the automatic underload device on the starting-box protects the motor from the accidental cutting out and throwing in again of the generator circuit.

Finish.—The engines, generators and motors upon completion, have been painted with two filler coats and one finishing coat of enamel paint, and each motor has, in addition, been plainly marked with a number, which designates the location of the motor in the building with respect to the floor and room.

THE LIGHTING SYSTEM.

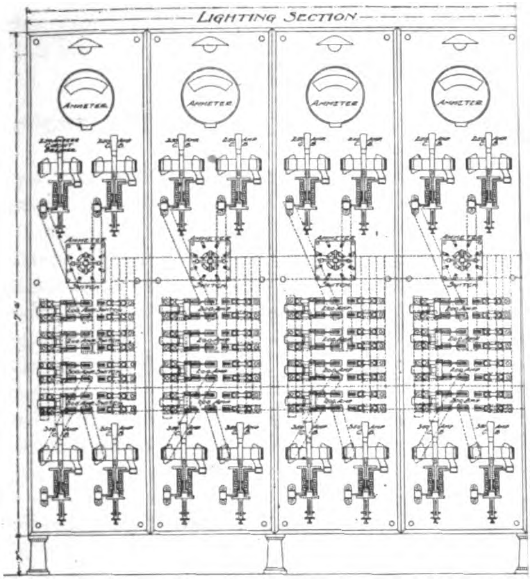
The lighting of this building is obtained by the combination of arc and incandescent lamps. Arc lamps are used as much as possible for the general illumination of rooms containing machinery. The lighting for special work in connection with small machines is obtained by incandescent drop pendants. The illumination of rooms containing apparatus for hand work at tables is obtained by means of a combination of arc lamps and incandescent lamp clusters, the arc lamps giving the required intensity of illumination and the incandescent lamps softening its quality. The arc lamps used throughout the building are Bergmann enclosed lamps with opalescent inner and outer globes, so as to obtain a complete diffusion of light with absence of sharp shadows. The floors devoted to storage are lighted with incandescent lamps, as are also the office and store floors.

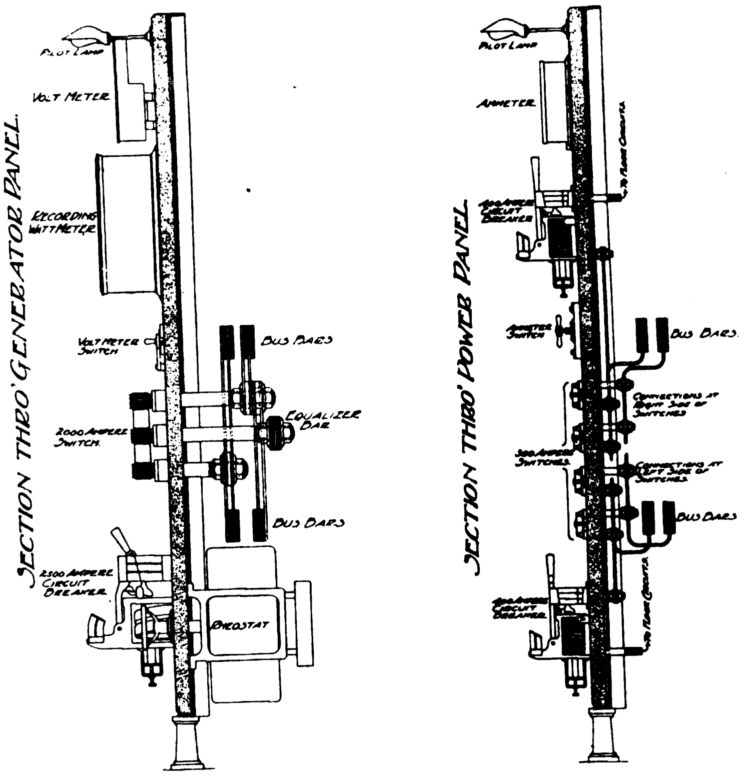
The rooms where the most careful and best illumination is necessary are those in which the lithographic presses are located. A brilliant illumination is obtained by a large number of enclosed-arc lamps, which are located with reference to the best possible distribution of light for the presses. As shown in Fig. 10, which gives one lithographic press floor, there are 28 arc lamps used for lighting 30 presses. By the use of arc lamps for this work, the most delicate distinctions of color can be made, and the pressmen are enabled to mix and match their colors as well at night as in the daytime.

The offices of the company are fitted with handsome fixtures, the incandescent lamps used in every case being shielded by means of ground-glass globes. The principal feature of the electrical illumination of these rooms is found in the art gallery. Here are shown a number of fine paintings, which have been used as originals for lithographic work. These pictures are lighted by rows of incandescent lamps placed in an alcove moulding at a distance of about 6 ft. from the wall, thus obtaining satisfactory illumination without interfering with the decorative proportions of the room, no fixtures being visible.

RESULTS.

This plant has been in complete operation for over six months past, and therefore the actual practical results of the electric equipment can be determined. The total capacity of engines is 660 HP, of gener-


LIGHTING SECTION
AMMETER
AMMETER
AMMETER
AMMETER


SECTION THRO' GENERATOR PANEL
PILOT LAMP
VOLT METER
RECORDING WATT METER
VOLT METER SWITCH
2000 AMPERE SWITCH
2500 AMPERE CIRCUIT BREAKER
BUS BARS
EQUALIZER BAR
BUS BARS
RHEOSTAT
SECTION THRO' POWER PANEL
PILOT LAMP
AMMETER
TO FLOOR CIRCUITS
CIRCUIT BREAKER
AMMETER SWITCH
BUS BARS
CONNECTIONS AT RIGHT SIDE OF SWITCHES
300 AMPERE SWITCHES
CONNECTIONS AT LEFT SIDE OF SWITCHES
BUS BARS
CIRCUIT BREAKER
TO FLOOR CIRCUITS

FIGS. 23 AND 24.—SWITCH-BOARD SECTIONS.

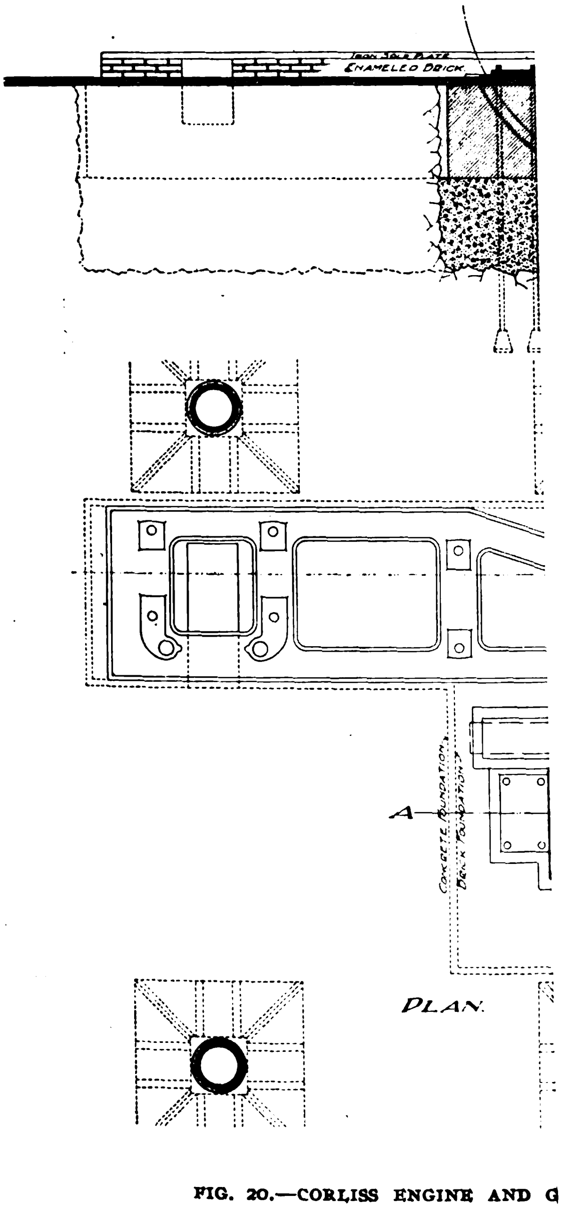

IRON SOLE PLATE
ENAMELED BRICK
CONCRETE FOUNDATION
BRICK FOUNDATION
A
PLAN.

FIG. 20.—CORLISS ENGINE AND G

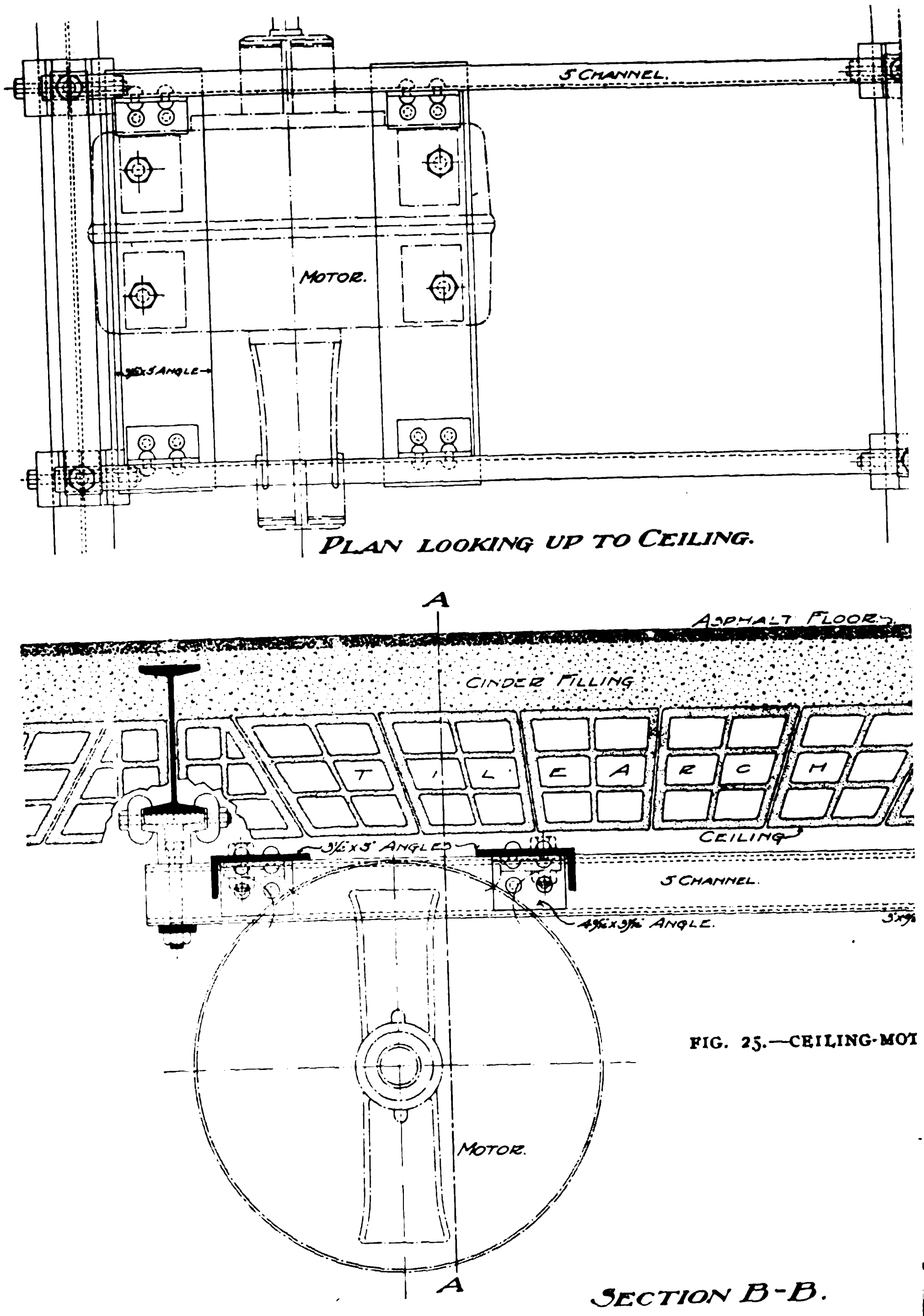
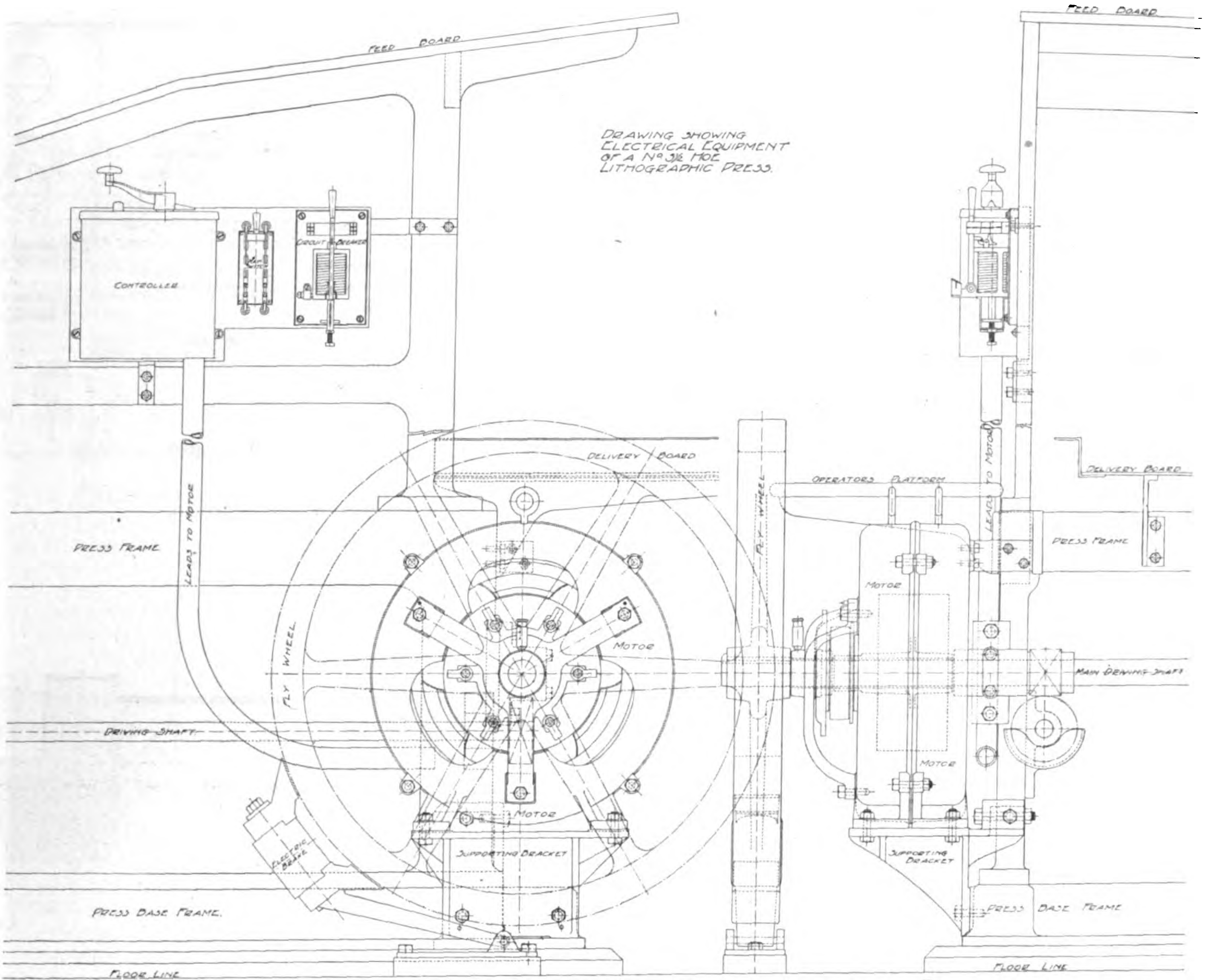

5 CHANNEL
MOTOR
3½x5 ANGLE
PLAN LOOKING UP TO CEILING.
A
ASPHALT FLOOR
CINDER FILLING
T I L E A R C H
CEILING
3½x5 ANGLES
5 CHANNEL
4½x3½ ANGLE
MOTOR
A
SECTION B-B.

FIG. 25.—CEILING-MOT

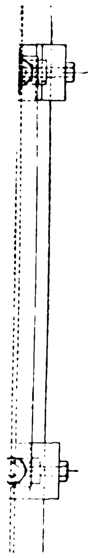
Details of Switch-board,
and Distributing Sy
of the American Lit

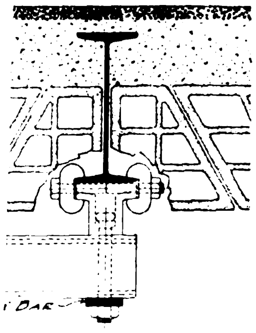
Ford, Bacon & Davis,
Engineers.


FEED BOARD
DRAWING SHOWING
ELECTRICAL EQUIPMENT
OF A Nº 3½ HOE
LITHOGRAPHIC PRESS.
CONTROLLER
CIRCUIT BREAKER
LEADS TO MOTOR
PRESS FRAME
FLY WHEEL
DRIVING SHAFT
DELIVERY BOARD
MOTOR
ELECTRIC BRAKE
SUPPORTING BRACKET
PRESS BASE FRAME
FLOOR LINE
FEED BOARD
OPERATORS PLATFORM
LEADS TO MOTOR
DELIVERY BOARD
PRESS FRAME
FLY WHEEL
MOTOR
MAIN DRIVING SHAFT
SUPPORTING BRACKET
PRESS BASE FRAME
FLOOR LINE

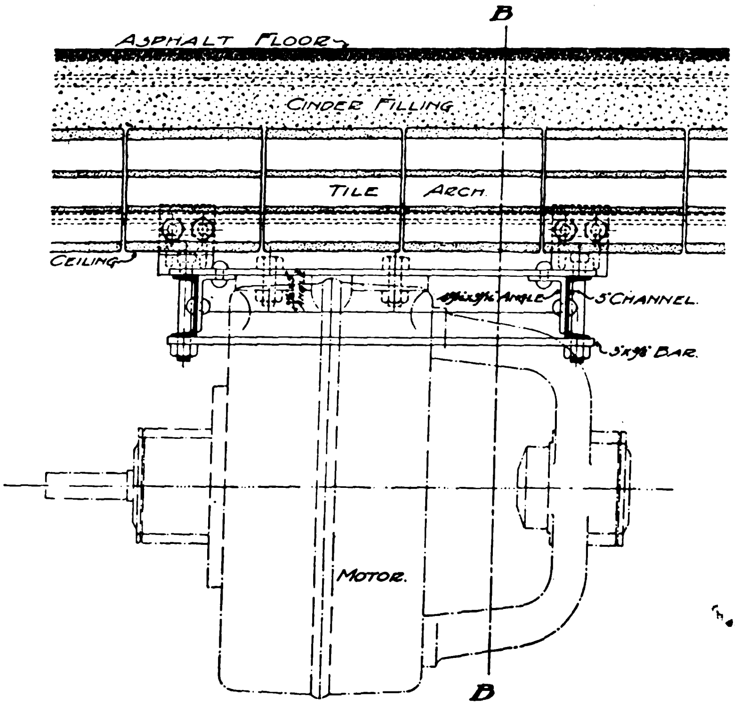
SIDE ELEVATION. END ELEVATION

FIG. 26.—LITHOGRAPHIC PRESS-MOTOR EQUIPMENT.





'OR SUSPENSION.


B
ASPHALT FLOOR
CINDER FILLING
TILE ARCH
CEILING
ANGLE
5"CHANNEL.
5"x⅜" BAR.
MOTOR.
B

SECTION A-A.

Detail Sheet showing Lithographic Press and Ceiling-Motor Equipments, and Sections of Switch-board.

ators 440 KW, and the rated capacity of all the motors installed is 847 HP. There are 3000 incandescent lamps and 140 arc lamps connected. During this time, the average electrical load at the switch-board has been approximately 200 HP, and the maximum load at the switch-board has been 2400 amperes at 115 volts or 370 HP. Thus the average load upon the plant is 17.6 per cent. of the total rated capacity of motors and lamps connected, while the maximum load is 32.7 per cent.

For the same period of six months, from the daily records of power produced, as recorded by the switch-board wattmeters, together with records of weighings of the amount of coal burned, it is found that each electrical HP-hour at the switchboard has been produced by 4.45 lbs. of coal. This includes the coal used for starting fires, banking fires over nights, Sundays and holidays, and also includes the running of the small high-speed unit for night work at an efficiency considerably less than the large Corliss engine units. Considering alone the operation of the large Corliss engine units in their daily ten-hour runs, during this same period they show an economy of 3.25 lbs. of coal per electrical HP-hour at the switchboard. The coal used is anthracite buckwheat.

Careful records are kept in the accounting department of the American Lithographic Company, covering all the items of the cost of manufacture. For the period during which the building has been in complete operation, comparisons have been made as to the cost of light and power in the new building with relation to the same period of former years. These figures include, for the present plant, the cost of fuel, wages of engineers, firemen and electricians, engineers' supplies, and gas bills. The figures for the same period of last year include cost of fuel, rented power, wages of engineers and firemen, engineers' supplies, and gas, and electric-light bills. Including all of these items, the cost of power and light in this new building per unit of manufactured product is 55.8 per cent. of the previous cost, or a saving of 44.2 per cent. Aside from this increased economy in the generation of power and light, there has been obtained a great improvement in the convenience of operation of the machinery and in the quality of the lighting, all of which tends to enhance the quality and increase the quantity of the manufactured product.

The officers of the American Lithographic Company are as follows: President, Joseph P. Knapp; first vice-president and purchasing agent, George W. Donaldson; second vice-president, Robt. M. Donaldson; treasurer, Louis Ettlinger; secretary, John R. Giles. Charles Eddy is superintendent of the company, and Wm. Hickey, chief engineer of the power plant.

The building, including the power plant and wiring construction, was erected for the American Lithographic Company by the the Central Real Estate Association under the direction of George P. Slade, treasurer, Alfred R. Kirkus, secretary, and Richard Berger, architect. The contractors for various portions of the electrical work were as follows: Engines; Watts-Campbell Company and Straight Line Engine Company. Generators; General Electric Company. Switchboard and wiring construction; New York Electric Equipment Company. Arc lamps and fixtures; General Incandescent Arc Light Company. Motors; Interior Conduit & Insulation Company. Elevators; McAdams & Cartwright Elevator Company.

Alfred R. Wolff was the consulting engineer for the steam-generating plant and for the steam-heating and ventilating apparatus.

For the electrical plant of the building, all the details of the engineering were performed by Ford, Bacon & Davis, Engineers, under whose supervision the equipment was installed, and by whom the foregoing plans were furnished to the *American Electrician*.

Charges for Electric Light and Power in New York City.

The New York Edison Illuminating Company has recently made some important reductions in the price of its electric service, the present rates being as follows: For incandescent lighting the price is 1 cent per 16-CP lamp-hour, including lamps. Discounts for quantity are given, ranging from 5 per cent. for $100 monthly, to 40 per cent. for $1000 or over; for long-hour use by customers using 5000 or more lamp-hours monthly, a further discount is given, ranging from 5 per cent. for 2 hours to 20 per cent. for 5 hours daily average. A minimum charge of $1.50 monthly is made. For arc lighting the price is 10 cents per 8-amp. lamp-hour, with discounts for quantity graded from 10 per cent. for 100 lamp-hours ($10) to 35 per cent. for 1000 lamp-hours ($100) or over per month; for long-hour use, to consumers of 2000 lamp-hours ($200), from 5 per cent. for an average burning of 100 lamp-hours ($10) to 15 per cent, for 200 lamp-hours ($20) monthly. The minimum charge is $3 per lamp. Consumers owning arc lamps are allowed a special discount of 10 per cent., and the minimum charge is reduced one-half, the company trimming and supplying carbons without additional charge. Power service is supplied at 10 cents per HP-hour, the discounts ranging from 20 per cent. for 100 HP-hours ($10) per month, to 50 per cent. for 1500 HP-hours ($150), 55 per cent. for 5000 HP-hours ($500), and 60 per cent. for 10,000 HP-hours ($1000). Long-hour use is taken into account in these figures. A wholesale price, on the kilowatt basis, is made to consumers using not less than 2500 KW-hours per month for lighting and power, with an average use of 2 hours or more daily, of 10 cents per KW-hour, the price including incandescent lamps, carbons and the trimming of arc lamps. Discounts are made of 1, 2 and 3 cents (10, 20 and 30 per cent.), for an average use of 4, 6 and 8 hours per day, and of ½ cent and 1 cent (5 per cent. and 10 per cent.) for use reaching 5000 KW-hours and 10,000 KW-hours, respectively, per month. When the consumer supplies incandescent lamps, carbons and the trimming of arc lamps, a further discount of 1 cent per KW-hour (10 per cent.) is made. In each case the percentage reduction applies to the gross bill. As will be seen, on the lamp-hour basis and 50-watt lamps, the minimum charge for incandescent lighting is as low as 8 cents per KW-hour, including renewals. For arc lighting, the minimum is 4 cents per 2000-CP lamp-hour, the consumer furnishing the lamp, but not trimming and carbons. The minimum rate for power service is 4 cents per HP-hour. On the kilowatt basis, the minimum is as low as 5 cents per KW-hour, or 3¾ cents per HP-hour, the consumer supplying renewals and trimming.

Alternating Currents for Electric Traction.

In a paper read at the December meeting of the Chicago Electrical Society, Mr. Cloyd Marshall expresses the opinion that with apparatus in the present state of development, the best plan for furnishing electric power to electric railways is to generate alternating currents at a place located with respect to the most favorable conditions, and to transmit them at high voltage to substations, where rotary converters will change to a direct current and supply sections of line of medium length. He considers that the recent improvements in alternating-current motors may lead to their adoption for street-railway work. Their speed may be regulated by changing the number of excited poles, since the speed is inversely proportional to the number of pairs of poles, and also by the introduction of resistance into the armature circuit. In recent experiments in Germany a single-phase motor with auxiliary starting coils gave a starting torque two and a half times normal in a short-circuited armature parallel to the exciting coils. While this starting torque is not so great as that obtained in a series motor, it could have been increased in the experiment quoted. In using the single-phase alternating current for electric power, Mr. Marshall considers that it is desirable to transmit it on one wire and use a phase-shifting or splitting device on the car for starting.

Heat-Unit Standard for Rating Electric Generating Plant.

At the annual meeting last month of the American Society of Mechanical Engineers, Prof. W. S. Aldrich read a paper supplemental to one read at the annual meeting last year, on the subject of the thermal rating of electrical plants. After discussing briefly the progress made in the past four years in the economic performance of steam-power electric plants, and showing that the very low economy of such plant is not entirely due to uneconomical engines and variable loads, he returns to the question of the heat-unit as a basis for the rating of plants. Such a system is pronounced both rational and scientific. Referring to the claim that the common rating of performance of pumping plants in foot-pounds per 1000 lbs. of steam would be amply sufficient for all purposes of rating electric plants for which the heat-unit basis is advocated, it is shown that such a basis would give results within one per cent. of what comparative ratings would be if based on the B. T. U. standard.

WINDINGS OF POLYPHASE ARMATURES.

BY J. P. STONE.

With the introduction of polyphase apparatus, a number of different windings have necessarily been developed, although all of them have the same general features. Since they are slightly different, it may be thought that they are of essentially different character. It is the object of this paper to illustrate how these windings are made, and to show that it is rather unessential what type of connections are used as far as behavior and output of machines is concerned.

The single-phase winding in its simplest form consists of a number of coils connected up so as to give alternate polarity all round the surface of the armature. Assume that an alternator has ten poles, we could thus have a winding consisting of ten coils, as illustrated in Fig. 1, each coil connected in reverse direction in regard to the preceding; or we could have a winding as illustrated in Fig. 2, consisting of five coils, which coils are connected so as to give the same polarity, but separated from each other by the pitch of the poles—that is, by the distance between two adjacent poles.

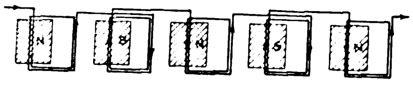


FIG. 1.—SINGLE-PHASE WINDING.

Necessarily, if all coils are connected so as to give the same polarity, the space between the coils will have the opposite polarity to that given by current passing through the coil.

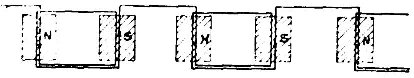


FIG. 2.—SINGLE-PHASE WINDING.

A two-phase generator could be made from a single-phase generator by adding a set of new coils placed midways between the first coils and wound in identically the same way as the first winding. Since the distance in phase between two adjacent poles is 108 degs., it is evident that the beginnings of the two independent windings will be 90 degs. apart; thus, if the two windings have the same number of turns, the generator will have two independent sources of power of same magnitude, one displaced 90 degs. from the other, that is, we have a two-phase generator with independent windings. Such a machine would then, of course, have four collector rings, two for each of the windings. By connecting two adjacent collector rings together, a two-phase relation still remains and we have a two-phase machine with interlinked winding.

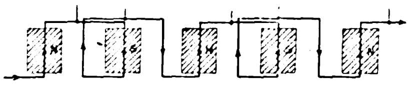


FIG. 3.—TWO-PHASE WINDING.

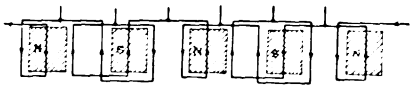
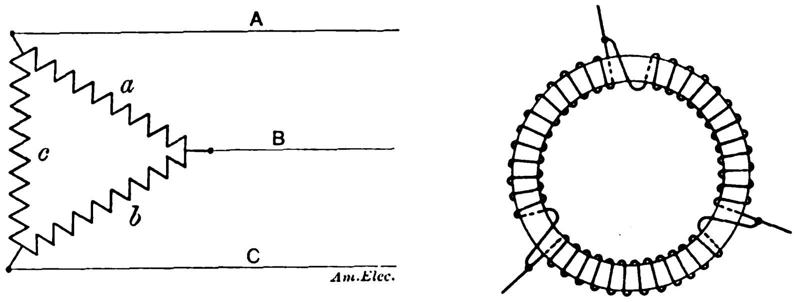


FIG. 4.—THREE-PHASE WINDING.

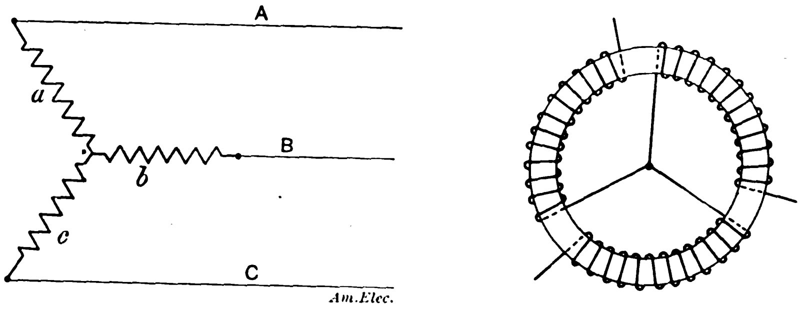
The same results can also be obtained from a distributed single-phase winding by proper connections, provided that the number of coils between each pair of poles is divisible by 2. Such a winding is illustrated in Fig. 3, and is, as can be seen, essentially a direct-current winding in which four taps are taken out to four collector rings (bipolar machine). Thus no new features in winding are introduced in making a two-phase generator.



FIGS. 5 AND 6.—THREE-PHASE DELTA WINDING.

A three-phase generator is made on essentially the same plan. It consists primarily of three independent single-phase windings, such as are described in Fig. 1 or 2, each starting 120 degs. in phase from the preceding; that is, since the distance between two pairs of poles is 360 degs., if the first winding starts midway under one pole, the second winding, wound identical with the first should start at one-third of the distance between two poles and the third at two-thirds the distance between the poles. Thus we see how a three-phase generator can be wound. If these circuits are not joined, six collector rings are necessary, two for each phase. Since, however, each winding has a point of equal potential with either of the other two, that point can be connected on all three.

That is, one end of each of their windings is brought to a common junction, from which they branch out starwise, and the remaining ends are connected to the three line wires. The three lines thus serve in turn as outgoing and return circuits, the maximum current shifting from one to the other in succession. We thus obtain a Y-connected machine which necessitates three collector rings only.



FIGS. 7 AND 8.—THREE-PHASE Y-WINDING.

Similar to what was stated regarding the two-phase winding, the three-phase winding can be obtained from the distributed single-phase winding by tapping the winding at suitable points; that is, points differing in phase by 120 degs. Such a winding is illustrated in Fig. 6, and is called the delta winding. This is also shown diagramatically in Fig. 5. Here the coils form a closed mesh, the six terminals being united two and two, the lines being connected to the windings at the three points of junction, forming a triangle. In order to make such connections, however, it is, of course, necessary that the single-phase winding should have at least 3 slots per pole and phase (for a full pitch winding) or a multiple of 3. Such a winding is illustrated in Fig. 4.

The three-phase windings can also be shown as simple Gramme windings, having only one coil per phase, as in Figs. 6 and 8, which are shown delta and Y connected, respectively. Thus it will be seen that a direct-current winding may be connected into a three-phase delta connected winding by tapping it at equidistant points, the number of leads being governed by the number of poles.

Denoting the E. M. F. induced in each winding by E, it is evident that the E. M. F. between the lines in a delta-connected armature must be E, since the lines are connected directly to the ends of the winding. In a Y-connected armature, however, one end of each of the 3 windings are connected together, and the other 3 ends are connected to the lines, as in Fig. 7; but, since the E. M. Fs. induced in each winding are not in phase with each other, the E. M. F. at the terminals is not the sum of the E. M. Fs. induced in each winding; that is, it is not $2E$, but is the geometrical sum of the E. M. Fs. in the two phases—that is $E\sqrt{3}$.

The output of a polyphase generator is that of the sum of each individual phase; that is, denoting the current in each wire in a Y-connected motor by C, and the E. M. F. induced in each phase as before, by E, the power of the three-phase generator is $3 \times CE$. Since, however, the E. M. F. between the lines is $\sqrt{3}$ times the E. M. F. per phase—that is $E \times \sqrt{3}$—we find that the power of a three-phase generator expressed by the line E. M. F. and line current must be $\sqrt{3} \times C_1 \times E_1$, where E_1 and C_1 and the E. M. Fs. and the currents, respectively, between the lines and in the lines. In a delta-wound motor, in the same manner, we find the power delivered to be expressed by the same equation.

Regarding choice of winding, in some cases, undoubtedly, one is preferred to the other. In such cases as with alternators where rectified current is used for compounding, the Y-connection adapts itself more readily, as the commutator can be connected in the common junction of the three phases.

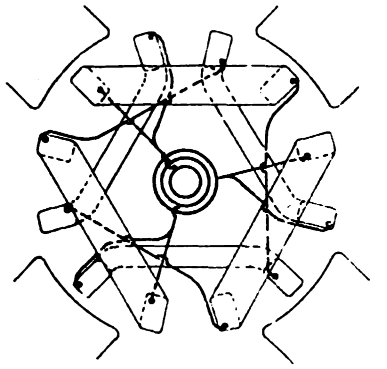


FIG. 9.—DELTA WINDING.

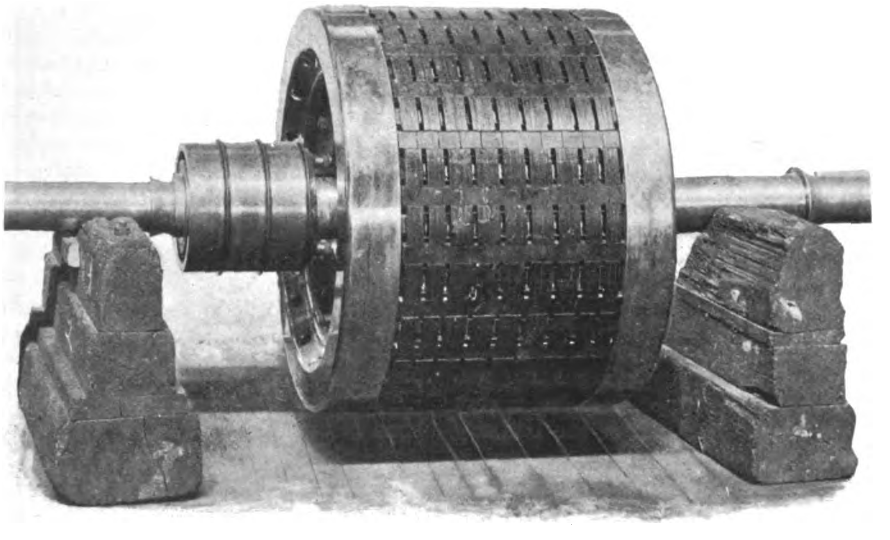


FIG. 10.—POLYPHASE ARMATURE.

The delta winding, however, is essential in generators which shall combine direct-current output or input with alternating-current output or input, such as a rotary converter, where, on account of the direct-current feature, the winding must be of the delta form; that is, must be continuous, as shown in Fig. 5, which represents a continuous winding tapped off at three points 120 degs. apart. Furthermore, by the choice of one or the other it is often possible to make a decidedly better motor, both mechanically and electrically.

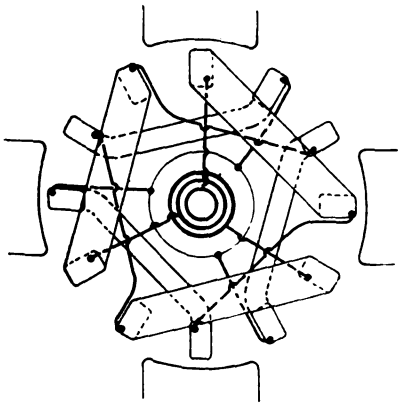


FIG. 11.—Y WINDING.

An armature designed for a given working voltage measured between the lines, would, if planned for Y-connection, have fewer turns of larger wire than if intended for delta connection. This is sometimes convenient, and is useful in keeping the voltage between coils low. The delta connection, on the other hand, has more turns of smaller wire, as the current is diminished while the E. M. F. in each coil is the full E. M. F. between the lines. This property is useful under certain conditions, as it makes the E. M. F. between any two lines somewhat less; for instance, in a machine with very large currents, the delta winding would be preferable, since in that winding the current in each wire is smaller than the line current (the line current being supplied from two phases as illustrated in Fig. 5). The contrary is the case in a machine for very high potential; it is often possible to get a simple winding by a Y-connection, since then the number of turns necessary to give the requisite voltage are less than those in a delta-connected winding.

The same winding can, of course, be connected Y or delta according to the dictates of convenience, as in Figs. 9 and 11 which show the same armature connected delta and Y respectively.

Thus it will be seen that the manner of connecting the windings of a multiphase armature is largely a matter of convenience, and thus does not influence the working of the machine.

A completed armature for a polyphase generator is shown in Fig. 10, the winding and connection of which are covered by a shield at each end to protect them from injury.

* * *

Junketing in England.

An English newspaper, according to our London contemporary, *Electricity*, is in a state of excitement because a party of fifteen municipal representatives out on a trip of examination of electric-light stations in the country, extending over three days, spent 2s 2d per head on drinks and cigars.

THE ENCLOSED-ARC LAMP.

BY WILLIAM H. FREEDMAN.

The enclosed arc of to-day has gained its position in the lighting world in the short period of three years, not only greatly increasing the total number of arcs installed but also in many instances supplanting the open arc. Its use has spread with marvelous rapidity, mainly due to the fact that it will burn without change of carbons from 75 to 100 hours, according to the make of the lamp, thereby saving considerable in carbons and trimmers' expenses. This long life of carbons, 15 to 20 times that in the open arc, has been obtained by the simple expedient of enclosing the arc within a small globe and preventing the free circulation of air around it. Upon starting the arc, the air in the enclosing globe gives up its oxygen, forming carbon monoxide and carbonic acid gas. The heat which in the open arc is radiated into the air is here confined and raises the temperature of the enclosed gases and carbon vapor. The arc proper is scarcely visible, but the entire contents of the enclosing or inner globe seem to be luminous, giving the appearance of a solid mass of light.

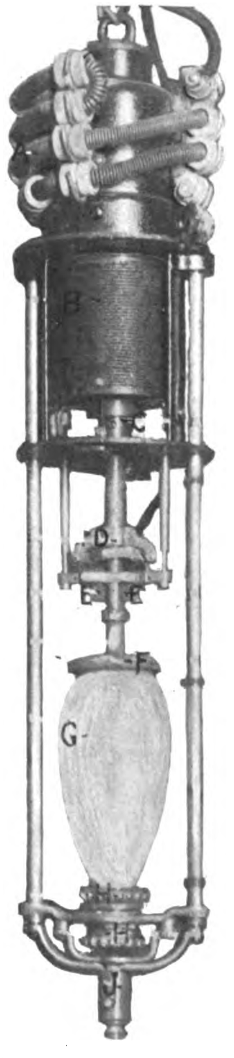


FIG. 1.—ENCLOSED-ARC LAMP.

Mechanism of the Enclosed-Arc Lamp.—All of the enclosed lamps now on the market, work on the same general principles. They are placed singly across the ordinary incandescent-lighting circuit, and are regulated to take, approximately, 80 volts across the arc, the rest of the potential being consumed in the regulating solenoid and extra resistance (shown in Fig. 1). The standard current is 5 amperes, the arc being about $\frac{5}{16}$ in. long. In indoor lighting where a strong light is not desired there are, however, quite a number of 3-ampere lamps in use.

The various parts of an enclosed-arc lamp are shown in Fig. 1. *A* is a resistance to cut down the voltage of the circuit to that required for the lamp; *B* is a solenoid which regulates the length of arc and feed of carbons; *P* is the core of the solenoid with a dash-pot arrangement added; *D E* is the friction-clutch mechanism; *F* is the gas cap (shown in detail in Fig. 4); *G* is inner globe, *HH* the lower carbon holder, and *D* the holder for the outer globe.

The current passes through the extra resistance, the solenoid and the carbons, in series. This series arrangement makes a very simple lamp, with very few parts, and working much steadier than the open-arc lamp. When no current is passing, the carbons touch; the moment the current is thrown on, the core is drawn up, and lifts the upper or positive carbon by means of a friction clutch. The negative carbon is fixed in a holder or socket, at the bottom of the lamp.

The simplest form of friction clutch consists of a straight horizontal rod fastened to the end of the plunger of the solenoid, and having at each end an arm so pivoted that the two arms cross each other like a letter D (as shown in Fig. 2). At each lower end of these arms is pivoted a friction piece, with either a rounded or V-shaped surface, which grasps the rod holding the upper carbon. Lifting the upper ends causes the lower ends to come nearer together, thus gripping the rod. The carbon and its rod are dropped when the device falls far enough to touch a stop which prevents the lower part of the clutch from coming down any further.

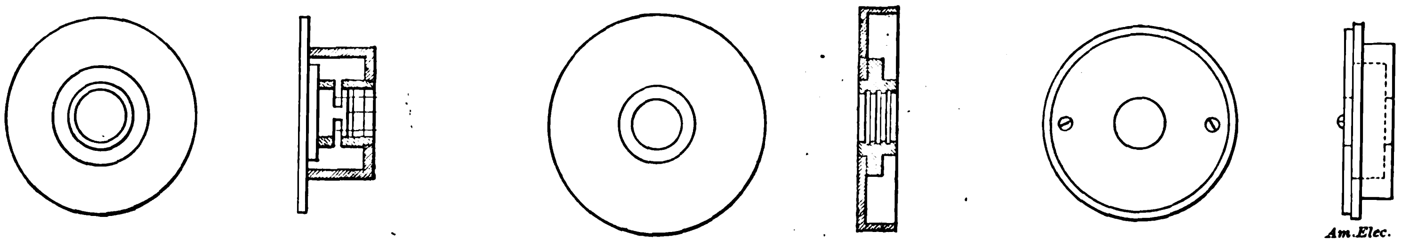


FIG. 4.—GAS CAPS—HALF ACTUAL SIZE.

A novel departure from this form of clutch consists of a cylindrical piece of brass fitting around the rod, and having its upper end grooved to hold a row of steel balls. These are held in place by a conically shaped cup. When the inner cylinder rests on the stop, the cup, which is attached to the plunger, descends far enough to release the friction on the balls by reason of its sloping sides, and the carbon rod falls. When the core is drawn up, the cup follows, the balls being caught in the apex of the cup, and the rod is drawn up.

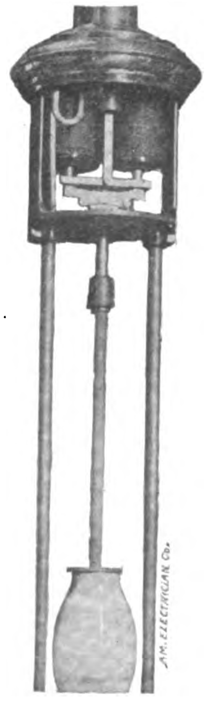


FIG. 2.—ENCLOSED-ARC LAMP.

As the carbons wear away, the armature of the solenoid gradually descends (the current remaining practically constant whatever the position of the plunger) until it reaches the stop that releases the carbon from the friction clutch; the carbon then falls and strikes the lower one, but is immediately picked up again—the light sometimes going out and sometimes remaining. This process, however, occurs at comparatively long intervals, as the core has a play of $\frac{3}{8}$ in. to $\frac{1}{2}$ in. before the stop is reached. The positive carbon wears away at the rate of .05 in., approximately, per hour, and the negative at half this rate; there will consequently be from five to eight hours between the times of the resetting of the core to its top position. The open-arc lamp, allowing a consumption of 1 in. per hour, feeds about fifteen to twenty times as often.

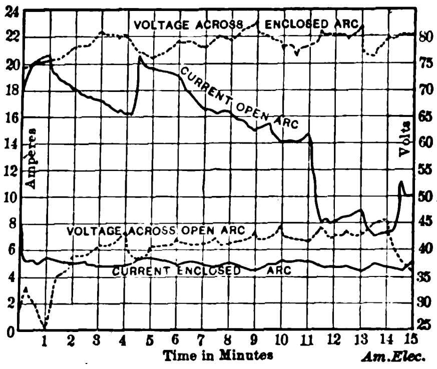


FIG. 3.—COMPARISON OF OPEN AND ENCLOSED-ARC REGULATION.

Regulation.—The simple regulating mechanism of the enclosed lamp has a very great advantage over that of the ordinary open lamp. The series mechanism used is not applicable to short-arc lamps, as a given variation makes a large proportional change, whereas this is obviated by using a long arc.

The current and voltage variation in both styles of lamp at starting, each on a constant-potential circuit of 115 volts and the open arc being one of two in series, are shown graphically by the curves of Fig. 3. The voltage is that across the arc. The normal currents were 4.75 amperes for the enclosed, and 8 amperes for the open-arc lamp.

The normal voltage across the arc, for 5 amperes, in the enclosed lamp is 80, which gives 400 watts expended at the arc; the remaining watts, due to a higher voltage of the circuit to which the arc is connected, is wasted in the extra resistance. On a 110-volt circuit, 72.7 per cent. of the energy supplied to the lamp is, therefore, spent at the carbon points. Eighty to 85 volts seems to be as high as is desirable in order to get the best regulation. Some extra resistance is necessary for regulation, as a given change in the resistance of the arc will make a less change relatively in the whole resistance when this is large.

Fig. 5 will be of interest in showing the steadiness it is possible to get in current and voltage across the arc. The readings were made every two seconds. Considering that the arc is constantly moving and that the external voltage is not absolutely steady, the regulation is very good.

Life of Carbons.—The life of the carbons of a lamp, for one trimming, depends on a large number of conditions, most of which are self-evident. 1°. It is influenced by the size and quality of carbons. 2°. It depends upon the current strength. 3°. The size of the enclosing globe affects the life. 4°. The position of the arc in the enclosing globe affects the rate of consumption of carbon. 5°. The form of the gas cap used changes the rate of ingress of air and egress of gases, thus affecting the life. Fig. 4 shows different styles of caps. They vary in form from a simple circular plate with the hole for the carbon grooved in two circles parallel with the plane of the disk, to the arrangement having a chamber fitted with slits through that wall which is next the carbon. The object of this chamber is to obstruct the circulation as much as possible, and yet have sufficient air to keep the carbon from depositing on the globe in excessive quantities. 6°. Whether the run is continuous or intermittent, changes the life, although slightly. 7°. Some lamps make use of an air-tight outer globe to keep down the supply of air, thereby slightly increasing the life.

The usual method of renewing the carbons is to use the remainder of the upper carbon for the negative in the next run. The lower carbon might even be used for two continuous runs, if the position of the arc in the lower portion of the globe is not objectionable.

The long life of the enclosed arc may be considered its chief advantage over the ordinary open arc, the saving in carbons and trimmers' expenses being very large. The old style of lamp requires two carbons for each trimming, and lasts six or eight hours. The enclosed arc requires to be trimmed about $\frac{1}{15}$ or $\frac{1}{20}$ as often. Furthermore, each re-trimming costs less. For, although the cost per 1000 for the same size carbon is greater for the enclosed arc, being $23 for 12 in. × $\frac{7}{16}$ in. rods, only one is required for retrimming, while the open arc needs two,

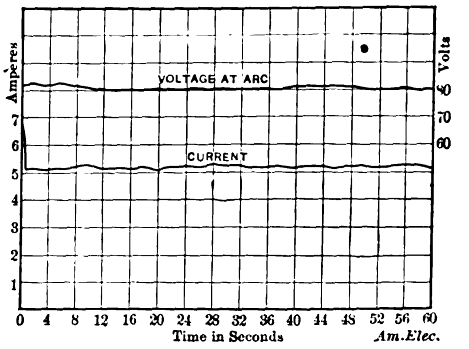


FIG. 5.—CURRENT AND VOLTAGE CURVES OF ENCLOSED ARC.

costing \$18.70 per 1000 for 12 in. × $\frac{7}{16}$ in. rods, and \$8.30 per 1000 for 6 in. × $\frac{7}{16}$ in. rods; so that 1000 retrimmings cost \$23 for the enclosed lamp, against \$27 for the open lamp, or a saving of \$4 per 1000 trimmings in favor of the enclosed-arc lamp.

Intensity aud Distribution of Light.— The distribution of light from an enclosed arc is somewhat different from that of an open arc, due to the different shape assumed by the carbons and to the different styles of globes employed.

Fig. 6 shows the difference in appearance between the two styles of arc. The enclosed arc burns flat on the top or positive carbon, the lower or negative one becoming slightly convex. The arc itself does not remain in any one spot, but wanders all around the flat ends. In the case of large carbons, this is objectionable, as it results in the casting of rather heavy shadows, but which, to a large extent, can be prevented by the use of proper globes. If the ends of the carbons are rounded slightly, the shadow is lessened, but the carbons burn flat again in a very short time.

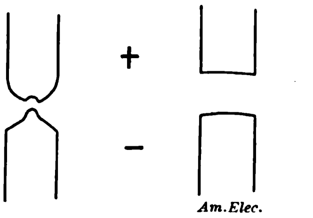


FIG. 6.—OPEN AND ENCLOSED ARCS.

The inner globes furnished by the different manufacturers vary, with respect to the glass, from a globe that will show the unlit carbons inside very plainly, to a type that while translucent, is not transparent. This latter form diffuses the light better than a thinner globe, although cutting off more light. All the opal globes, when held up to a window, show a reddish orange color, which has the effect of softening the violet light cast by the naked arc. The use of a fairly dense opal inner globe and a light outer globe, gives a soft light that is pleasing to the eye and free from shadows. When an opal globe is used, it appears like a solid source of light. It is this effect that does away with the shadows of the side rods. The shadow cast by the bottom of the lamp is also made very small, so that the effect to the eye is that of a bright, even illumination, apparently as much as the illumination from the naked arc, although the intensity has been cut down considerably by the globes. This is due to the fact that a light very intense in one spot seems to give no more illumination than a diffused light of smaller total value.

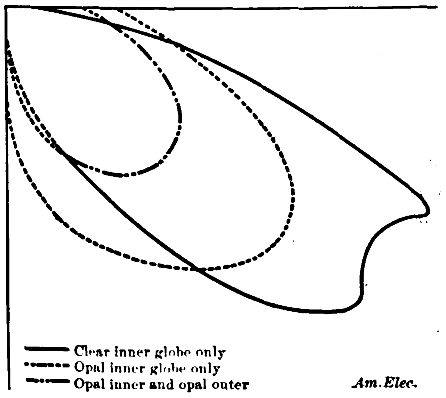


FIG. 7.—DISTRIBUTION OF LIGHT FROM ENCLOSED ARCS.

The distribution given by an open-arc lamp is not the same as that from an enclosed-arc lamp. The maximum in the latter is at an angle of 25 degs. below the horizontal instead of 40 degs. The intensity, after decreasing, reaches another high value at 40 degs., but not quite as great as at 25 degs.

The comparative distribution of light from enclosed arcs is shown graphically in Fig. 7. It will be seen that the enclosed arc gives a wide zone of illumination that is not far from the maximum. The curves of Fig. 7 as well as those of Figs. 3 and 4, are from the data of experiments conducted by Messrs. Burroughs and Rapaport, at Columbia University.

Conclusion. — Besides direct-current enclosed arcs, there are now on the market several makes of alternating enclosed arcs. These have the advantage over the open that the energy employed at the arc may be a higher percentage of the total energy supplied than in the direct. They, however, work best at one particular frequency, which might be in some cases a serious objection.

In general, the enclosed-arc lamp as compared with the open has the following advantages:

Long life, and consequent saving of carbon, trimming expenses and annoyance from frequent renewals; pleasant light, free from hissing and spluttering, and with very little flickering; absence from flying dust and sparks, and fireproof qualities resulting from the use of two globes; being run on the incandescent circuit, there is no danger from high potentials, and no need of an automatic cut-out; simplicity of mechanism, and, consequently, less need of repairs. Ability to install only one lamp and not necessarily two.

Against the above are, however, to be balanced the disadvantages of lower efficiency, and decrease of light with the time of running.

FUSES vs. CIRCUIT BREAKERS.

ACTION OF FUSES AND CIRCUIT BREAKERS.

BY L. W. DOWNES.

Having given considerable attention to the subject of fuses, I read with interest the two articles in your last issue which bear upon this subject—one by Mr. Harrington, and another by Mr. Sachs.

I beg, however, to call attention to certain statements that I believe need some modification. Mr. Harrington in his criticism of Mr. Cutler's paper, expresses surprise that he is not acquainted with the advantages of a device "that will open the circuit more and more quickly as the current causing such opening, increases," apparently assuming, or at least giving an impression, that he does not consider that this is a feature possessed by the fuse, even to a greater degree than the circuit-breaker.

Certainly no greater mistake could have been made than assuming that this is a feature alone of circuit-breakers. As a matter of fact, when we consider the cause of operation of the fuse, it will be seen that the ratio of the rate of operation, for increased current strength, is far more rapid in the fuse than in the circuit-breaker, since in the fuse the heating effect increases as the square of the current, the resistance of the fuse itself at the same time rising.

With the circuit-breaker, however, dependent as it is upon the magnetic effect, the magneto-motive force, or force tending to operate the armature, is by no means even proportional to the rise in current, except possibly at a very low magnetic density, much less its square.

I do not, of course, wish to give the impression by this, that I mean that the fuse is more rapid in its operation than the circuit-breaker, but to call attention to the oversight. He further goes on to state that the reason why circuit-breakers are preferable to fuses, even in the extreme case of elevator motors, is due to the uncertainty and unreliability of the latter.

This may be partially true for fuses of imperfect design, but for those constructed upon correct principles, this no longer holds as an argument, since they are quite as accurate as any circuit-breaker, and far more certain in their operation. Mr. Harrington then speaks of "the notoriously bad quality of fuses in permitting such enormous currents to flow in event of a short-circuit, giving an empirical formula established by himself, for the current flowing on short circuit, with fuses of various composition.

The method employed by Mr. Harrington in establishing this formula was, I believe, to use a circuit-breaker in series with the fuse, assuming that the knocking off point of such a device would indicate the maximum current flowing. It can scarcely be questioned that a formula established by such a method would be anything but correct, since the breaker is in no way adapted to the measurement of sudden rushes of current. Moreover, such a formula could not by any possibility be correct for any circuit, if at all, other than the one in which the measurements were made, since the actual current flowing on short-circuit is dependent on more than the factors of resistance and E. M. F., namely, the inductance of the circuit; at every instant during the rise of the current, since the sudden rise of current value in any circuit is opposed by a counter E. M. F., the magnitude of this factor would be dependent entirely on the conditions in the circuit. That such is the case is shown by Helmholtz' formula, to which reference is made by Mr. Harrington in the first part of his paper and which was apparently lost sight of.

It cannot be assumed from this that the fuse will permit a greater current to flow on short circuit than a circuit-breaker of equal capacity, for the short time interval in the fuse under such circumstances is about equalled by the friction and inertia of the latter; moreover, if such was the case, the breaker should operate first, whereas, as a matter of fact, it will be found, that with a properly designed fuse connected in series with a breaker which is set at a point not greatly in excess of the normal load of the fuse, it will, on short circuit, apparently operate later than the fuse, since there is no sign of flash or spark at the carbon blades; and further, if breakers will not permit of these abnormal rushes of current, why is it that it is not an unusual occurrence for those of excellent design to be totally destroyed by a short circuit, for this certainly could not take place without excessive current being involved?

In fact, Mr. Harrington, I think, loses sight of the point that is now generally admitted by engineers, namely, that for properly designed fuses there is a wide field of usefulness to which circuit-breakers are not applicable, and certainly this field is not as petty as he would intimate. On the other hand, there is an equally wide field of usefulness for the circuit-breaker, and one for which it will unquestionably be used.

Mr. Sachs in his support of fuses, advocates a method of rating that is somewhat at fault, since he says "Would not the proper method be to rate it at its maximum continuous carrying capacity, and at the percentage of overload blowing current?" In the first place, rating at the maximum continuous carrying capacity would be quite as vague as the present method of most manufacturers, unless a fixed standard for the surrounding temperature be taken, since the rise in temperature in any body due to the flow of current through it, is from and above the temperature of the surrounding air, and a fuse calibrated in this way at 60 degs. would not by any means carry the same current at 80, 90, or 100 degs.; no mention of this, however, is made by Mr. Sachs.

Obviously, a definite temperature for calibration must be taken, especially for fuses of the enclosed type, in which the temperature of the mass of adjacent material affects the blowing time for any given overload value. Moreover, I fail to see the advantage of including the time factor for any percentage of overload, since unless the whole curve of time factors for different overloads were given, the chances are, that a knowledge of what it was at any arbitrary point, would be of little or no assistance to the user. Further, Mr. Sachs, referring to a fuse recently described by me in an article on the subject, says that while the "device mentioned accomplishes excellent results, the fuse actually blows in an air chamber inside the enclosing jacket and therefore retains some of the objections of the air fuse," apparently failing to realize that an enclosed fuse constructed as described is quite worthless as a protective device, except in cases of short circuit, without the chamber, for the reason that its maximum carrying capacity changes with the length of time the fuse is in circuit, gradually becoming less as the mass of surrounding material becomes heated, with a proportional change in its blowing time, for any given overload factor.

As this change is a very large percentage of its actual carrying capacity at maximum temperature, a fuse which hot would be a protection, cold, is no protection at all. By the use of the air chamber this defect is nearly eliminated, the difference in blowing time for any given overload between a cold fuse and one that has been in circuit for sometime, being but a very small percentage.

The calibration of such fuses to their maximum carrying capacity at a given temperature is, however, a very tedious process, requiring the most careful attention for many hours, as with large sizes it requires from eight to ten hours for the mass to reach its maximum temperature.

Mr. Sachs then describes a fuse of his own design, stating that they can be built to blow on 10 per cent. or even less above its continuous running point. The intention of the author of the paper at this point is somewhat obscure, as without any mention of time value, he practically says, that a fuse which will carry a certain definite current and no more, will melt at 10 per cent., or even less excess of this maximum current value. What there is remarkable about this, it is difficult to comprehend, since it must of necessity be true of any fuse, whether enclosed or not. In the assumption that it is impossible to construct air-suspended fuses, with a short time interval, is another error, as it is possible to secure almost any desired time factor by a suitable adjustment of the various parts.

The one-second operating point spoken of by Mr. Sachs, which I presume is for a 10 per cent. overload, is, I believe, for too high a a degree of sensitiveness for ordinary commercial work, as it would result in the so frequent blowing of fuses as to be a great source of anoyance. The underwriters after careful consideration of data on this subject, state that the operation of a fuse at 30 per cent. excess of current in two minutes gives ample protection to either wiring or apparatus, and my own experience in this direction would indicate that, with the exception of lamps, this rating is well within the safety limits, while for motor installation, I believe a higher value preferable.

CIRCUIT-BREAKERS.

BY WALTER E. HARRINGTON, B. S.

The two articles in the December issue upon circuit interrupting methods are very interesting to me, owing to the emphatic and positive assertions made by both writers, upon premises which experienced engineers know to be wrong. Of course, when such arguments are adduced and statements made contrary to facts, the controversy then departs from one of engineering interest.

Mr. Cutler states that the article by Joseph Sachs "is sound engineering from beginning to end;" that "I agree with every word of it, and would not ask for a better support in the position I have taken." Now notice the peculiarly inconsistent position in which Mr. Cutler has unwittingly placed himself. I will quote from Mr. Sachs' article, last issue of American Electrician, "How can it possibly be good engineering to adopt an expensive and comparatively complicated device to do exactly that which can be accurately accomplished by one far simpler and cheaper?" "The use of one effect of the current to guard against results due to another cannot be basically correct."

In face of the above, Mr. Cutler unfolds before us a device combining the heating and magnetic effects of the current, as one of the methods to properly protect circuits.

Both Mr. Cutler and Mr. Sachs are very positive that "a properly designed fuse will open the circuit as quickly on heavy overloads as a circuit-breaker." From this I most emphatically differ, and upon this statement of fact hinges the whole situation. It is their argument. If granting their assumption were correct, then such engineers as Dr. Cary T. Hutchinson, C. O. Mailloux, Gano S. Dunn, etc., must be mistaken. I think the reader will draw his own conclusions as to this.

Personally, while I have no interest whatever in circuit-breakers at this writing, I took up the cudgel owing to the speciousness of the arguments advanced. In looking for the animus of the attacks I am informed that both writers are financially interested in cartridge fuses.

I believe that such fuses are better than open fuses if a uniform standard were adopted and never departed from. But Mr. Jos. Sachs is advocating a cartridge fuse which, of course, will be a different standard than the one advocated by Mr. Cutler.

Engineers will be confronted with the same multitude of different sizes, kinds of fuse blocks and infinity of design, etc., as have characterized the fuse field. Already, before the first cartridge fuse is barely established, another is proposed which is better (?).

Mr. Sachs states in connection with the cartridge fuse, in which Mr. Cutler, I am informed, is interested, that "the device above mentioned accomplishes excellent results, but, etc., and therefore still retains some of the objections of the air fuse."

The above indicates the true reason fuses will and never can be considered in the light of a proper protecting device, as the variables entering into the proper calibration or determination are so many that no two manufacturers would produce a similar type of fuse, and the same unfortunate diversity of conditions, sizes, shapes, alloy, length, position, method of enclosure, kind of contacts, character of current and age; thus the fuses placed upon the market would soon assume the proportions that now bewilder the layman upon investigating the fuse question. The magnetic circuit-breaker is a device which, by its simplicity of construction, self contained adjustment and freedom from the effects of its environment make it just what it has grown to be—an excellent and well balanced engineering device for the protection of electric circuits from abnormal current flow.

A Cyclist Did It.

The whole of the vast continent of Australia was practically cut off from European news for nearly twenty-four hours in the middle of September, in consequence of an interruption on the line between Adelaide and Port Darwin. Enquiries were made, and it was found that the wire had been cut by a cyclist who was taken ill in the wilderness and wished to summons help. It is not related how he set about it, but he had the satisfaction at any rate of being found by repairmen.

ELECTRIC-LIGHT AND POWER PLANT FOR SMELTING WORKS.

BY F. HOFFMEISTER.

The largest smelter in Canada is now running by electricity, being that of the British Columbia Smelting & Refining Company at Trail, B. C. Perhaps the most interesting feature of the plant is the water supply by which it is operated. The water comes from Trail Rock and Stoney creeks, and is emptied into a reservoir about one mile from Trail. The reservoir is tapped by two steel pipes, one 22 ins. and the other 16 ins. in diameter, which carry the water to the edge of Smelter Hill, directly above the electric station. Here the 16-in. pipe divides its flow, part going to the smelter for use in disintegrating the slag, and the remainder down the hill to the power house below through a riveted steel pipe.

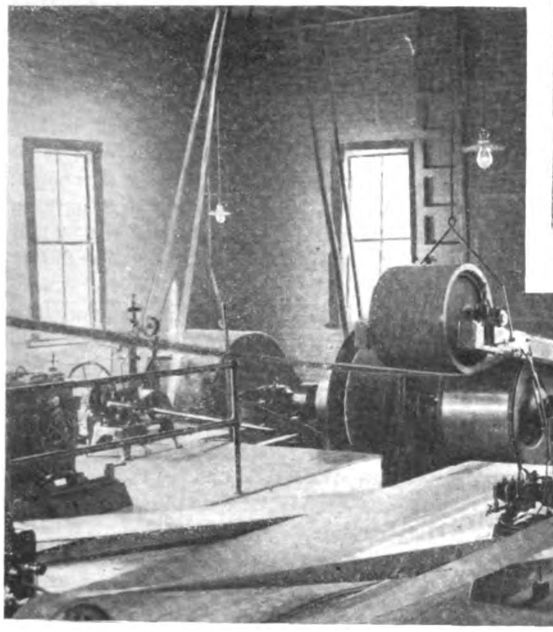


FIG. 1.—SHOWING WATER WHEELS, GOVERNOR AND SHAFTING.

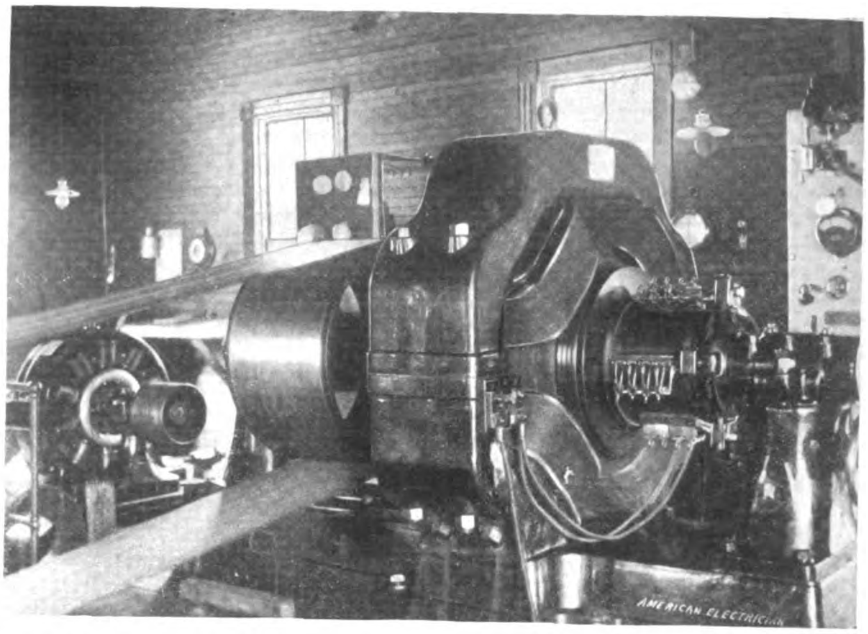


FIG. 3.—POWER GENERATOR AND ALTERNATOR.

The pipe is 22 ins. in diameter and runs at an average incline of 42 degs., with a head of about 200 ft., which gives in all a 260-ft. head at the water wheels. Just before entering the power house the pipe divides and feeds two 36-in. Pelton water wheels, which generate about 400 HP. From the Pelton wheels the power is transmitted by belts to the electric generators, which are three in number, supplied by the Canadian General Electric Company. Chief among these is the 200-KW power generator, which is the largest machine of its class in the province. This is to replace the steam engine in the smelter, which will result in a great saving of fuel expense. The current from the generator will be transformed into power by two motors of 125 HP each.

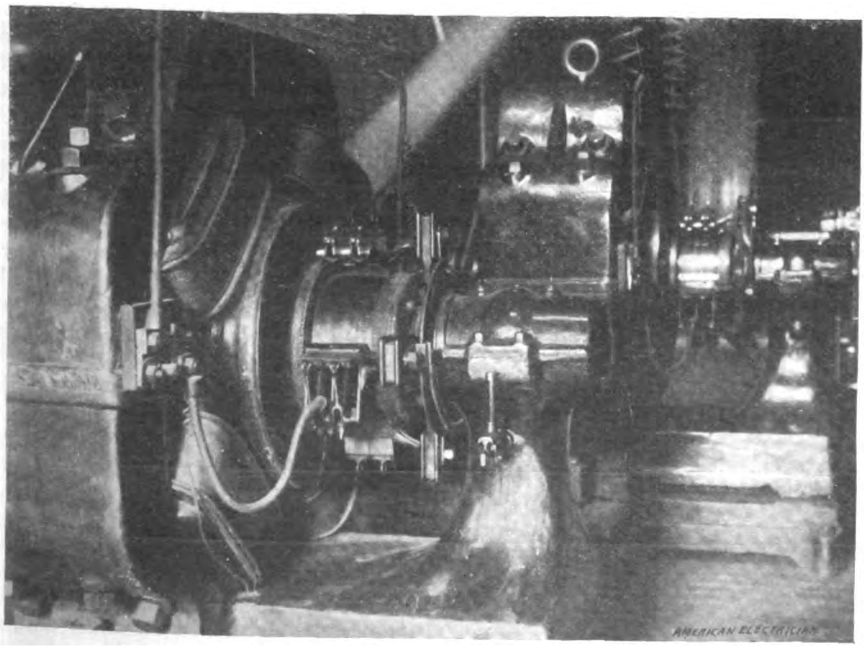


FIG. 2.—TWO 125-HP MOTORS.

The other dynamos in a power house are a 60-KW alternator T.-H. system, a 3-KW Edison type exciter, and a 15-light Wood arc machine. The switch-boards are of fine Tennessee marble, with the latest improved instruments, and finished with nickel-plated trimmings.

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ELECTRICAL SPECTACULAR EFFECTS,

BY C. R. PERSONS.

Some two years since the writer wired the Third Baptist Church, of San Francisco, for electric lighting, forty lights being installed in the auditorium and eighteen in the basement, including two portables. All the auditorium lights are controlled by three D. P. Hart switches placed in the front under the gallery stairs. The lights on the organ are run on the basement circuit and controlled by key sockets. Under the organ is a socket controlled by a switch, which is used for special work, as will be described later on. The current is alternating, of 114 volts.

About the time I wired the building a society of the church held an Oriental Bazaar, in connection with which I arranged an electric march and drill as follows:

Across the room were run two circuits of bare wire (No. 14 B. & S.), arranged about 18 ins. below the ceiling and run from wall to wall, each wire, of course, being on porcelain insulators. Wires of opposite polarity were about 3 ins. apart, each circuit being about 7 ft. apart. Fig. 1 will make the plan easily understood. A double-pole, double-throw knife-switch was connected in circuit in such a way that one throw would light all

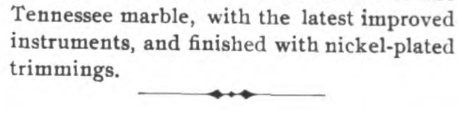

FIG. 1.—PLAN OF WIRING.

the lamps in the room, and the other send the current into the bare wires before mentioned.

The young ladies had arranged a very pretty march, in connection with which the above arrangement was used. Upon a certain bar of music being played, they would halt and salute by raising their wands in a straight line over their heads; two spring brass clips on top of sticks then made a light contact with the bare copper wires; the operator at the same time would throw the switch in the opposite direction, the lights in the room were extinguished and the lamps on top of the wands would light up, making a beautiful effect, especially as the lamps were of all colors. Before the audience could realize it, the switch was thrown in the other direction and the girls were marching away in splendid style.

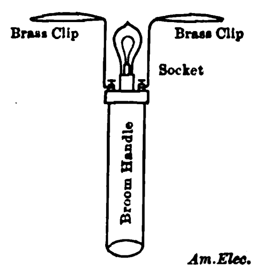

FIG. 2.—ELECTRICAL WAND.

I should mention that a third wire was run immediately in front of the copper wires; this was hung with ivy or evergreen, and served to conceal from the audience the method of lighting the lamps.

Fig. 2 will illustrate the method of making the electric wands. The wand itself was made of a broom handle, an ordinary lamp receptacle (such as is used for open work) being screwed to the top; two short strips of brass, with the ends extended, served to make contact with the wires overhead.

The entire outfit (wands and all) did not take over an hour to make up, and we had the electric drill a number of evenings with great success. It is best to rehearse about an hour, as some of the girls get nervous when it comes to making contact with the wires. The wires should be very carefully put up and connection to the switch should be made through a double-pole fuse block.

Churches generally are in debt—in fact, a church without a debt is like Hamlet with Hamlet out; the above mentioned church is not an exception, and in order to get rid of part of the debt, a performance was recently given of the well known scriptural cantata "Ruth." This gave an opportunity to introduce a number of beautiful effects, among which was a sunrise, a noon, a sunset, a moonrise, stars and a vision of two angels. The stage was wired as is shown in Fig. 3.

The method of operation is easily shown by the plan; in this case the portable stage (which is 26 ft. × 20 ft. with a proscenium opening of 15 ft. × 9 ft.) was carefully wired with annunciator wire run on porcelain insulators. Connection to the mains was made by the plug receptacle under the organ mentioned before. Any one of ordinary skill can make the switch which was used, as follows:

Procure a piece of hardwood, slate or marble, 7 ins. × 7 ins. × ½ in. thickness. At a slight cost, one can purchase from a model dealer a brass wheel 6 ins. in diameter; removing the spokes and hub, and we have a ring of brass, one face of which should be carefully turned up, and then divided into as many parts as desired (ours is in 10 sections). Mount these pieces of brass on the slate back by means of 10-24 screws, with a nut arranged to fasten tight on the rear side of switch-board. The switch will now look something like Fig. 4.

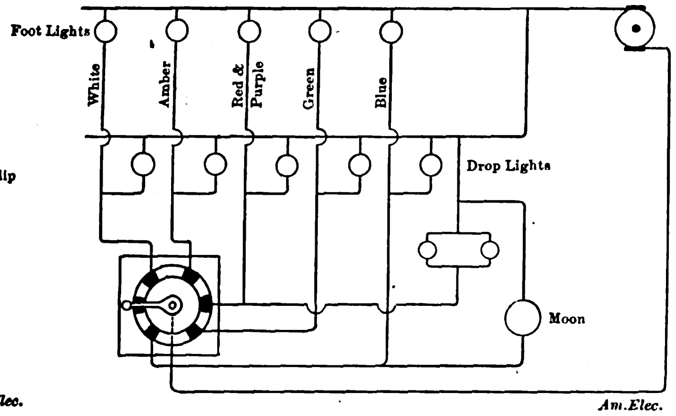

FIG. 3.—STAGE WIRING.

To make the handle and contact arm, fasten a short length of brass tubing on to a square brass plate, which tube is to contain a steel pin or shaft (a half-inch shaft will do), fitting snugly; a $\frac{1}{8}$ in. copper contact arm is made and fastened to the top of steel shaft by a nut, the upper end of shaft being threaded by a 10-24 die for this purpose. The shaft is firmly secured to the hollow brass pillar by a couple of nuts, one being, of course, a jam nut. The entire affair (pillar, shaft and all) is fastened to slate base by four 10-24 bolts, one of which is used to make electrical contact with the mains.

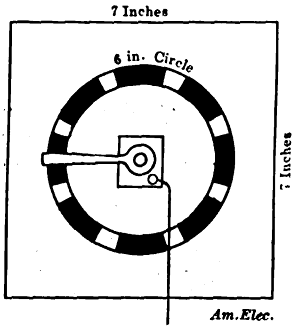

FIG. 4.—COMMUTATING SWITCH.

Of course, the contact arm must turn smoothly and easily, and make perfect electrical contact with the brass pieces. I have given no exact measurements for all the parts, as the switch can be made of any size and to carry any number of amperes. The edges of the contact arm and of the brass blocks must be slightly beveled, so that the make-and-break is easily accomplished, as otherwise vicious arcing will cause the lights to flicker in an unpleasant manner. A hard-rubber handle should be fastened to the contact arm. The arm must be wide enough to bridge the space between the brass contacts.

In "Ruth" the sunset effects were produced by the contact lever connecting red and purple lamps to the mains and cutting out the white lights. A 16-CP lamp may be connected in series to one main by an ordinary lever bell switch, which lamp can be used as a dimmer.

The moonlight effect was very easily produced by blue lamps. Arranged behind the back scene was a moon made out of a wooden box lined with tin, the face of the box having a round hole cut in it, over which was placed a piece of light blue tissue paper; a frosted 16-CP lamp in the box gave an almost perfect representation of "Fair Luna." The church was darkened during performance.

For a church entertainment, very few lamps are required; in "Ruth" were used four red, four blue, three purple, two amber, ten white and four green. A number of other lamps were used on the stage floor, concealed in boxes covered with colored gelatine. Dipped lamps may be used, but care must be exercised, as the coloring scales off easily.

The footlights and border lights must be connected on the same line running to the switch, so that corresponding colors will operate at the same time. Purple lights should be used to light the top of the back flat for sunset, with red footlights and red or amber lights over center of stage; all these lights should be fastened to a batten running over the top of the stage.

In working around churches it is frequently necessary to make something out of nothing (as churches are generally not burdened with cash), so we were compelled to use coal oil cans for reflectors—not quite so good as Frink's, but still they did fairly.

We have a powerful clock movement which fastens to the bottom of the steel shaft of switch, and during the Christian Endeavor Convention of July, we operated a large "C. E." monogram on the church tower by alternately lighting and extinguishing it every ten seconds, the clock movement operating two and a half hours each evening. During the Christmas season last year we illuminated the Sunday school Christmas tree with small lamps.

JACQUES CELL DISCUSSION.

The Jacques Cell.

To the Editor of American Electrician:

You desire to know my opinion about the "Jacques Cell" question discussed by Messrs. Anthony and Reed in the columns of the AMERICAN ELECTRICIAN. I must confess that I have not been able to find either time or patience to study very closely the various stages of the discussion which have been much confused, but as the question has finally reached a definite point, viz, the following: "Which are the electrochemical processes that are possible in this cell?" it may be perhaps of advantage if I illustrate the relations involved by a more familiar case.

Everybody knows the cell of Lalande,

which consists of copper oxide and zinc in sodium hydrate. It has an E. M. F. of 0.8 volt and, under the action of the current, the zinc dissolves on the one hand, forming sodium zincate, Na_2ZnO_2, while on the other hand the oxide of copper is reduced to copper.*

The cell becomes exhausted as soon as any one of the three substances, zinc, copper oxide or sodium hydrate is used up. In case all of the oxide of copper is reduced to copper, the cell can be restored to action by exposing the plate to the air, thus permitting the porous copper to be oxidized, this being in fact what is actually done in practice.

We possess in this cell the complete analogue of the Jacques cell. The rôle of the zinc is played by carbon, the rôle of the oxide of copper by ferric oxide, or by sodium ferrate. The cell will work until one of the three necessary constituents is exhausted. Since, in the Jacques arrangement, ferric oxide is the constituent present in the smallest quantity, the activity of the cell depends entirely upon the renewal of the exhausted ferric oxide, *i. e.*, of the amount of air or oxygen which is conveyed to the iron cathode.

If we were to construct the Lalande cell with plates of porous metallic copper instead of copper oxide, we should then be able to obtain a current from it only in proportion as fresh copper oxide is generated, say, by the blowing in of air to the cathode, or by allowing the latter to partially project in the air, and giving it a slow rotary movement, in such a manner that the reduced parts should be periodically exposed to the air.

As may be seen, in this cell as well as in the Jacques cell, the only active substance is the absorbed oxygen, and the energy which is set free by the union of the oxygen with the copper or the iron, is lost as far as the electrical process is concerned. There is practically no way known as yet for preventing this loss. If the cathode of the Jacques cell consisted of any non-oxidizable metal which would simply absorb the oxygen, as palladium absorbs hydrogen, a far higher E. M. F. might be secured, because in this case the chemical potential of free oxygen of the air, which is very high, would become effective. Free oxygen, however, is unfortunately a substance which, despite its high potential, reacts very slowly, and in order to realize practical velocities of reaction, we must put up with the loss of potential resulting from the oxidation of copper or iron.

Hence the difficulty of the problem of obtaining electricity from coal does not rest so much with the coal as with the oxygen. Theoretically it is solved in the gas battery of Grove, consisting of carbon monoxide and oxygen; the practical difficulty with this lies merely in the fact that under present known conditions these substances react too slowly, and consequently the apparatus involves too great first cost and interest. Even in the Jacques cell, it appears the oxidation of the coal takes place quickly enough; the slowest process, which determines the final result, is the taking up of free oxygen by the cathode.

When the current passes through the Jacques cell, the sodium ions move to the cathode containing ferric oxide, which thereby becomes reduced. The hydroxyl ions move to the coal, and form with the latter and the sodium hydrate present, sodium carbonate and water. As may be seen from this, oxygen is necessary only at the cathode, and every atom of oxygen which, in the free or combined state reaches the coal and burns it directly, represents a loss of electrical energy, just as does the "local" solution of zinc in the sulphuric acid of a Bunsen cell. In the computation of the total energy developed by the reaction, it is not necessary to take into account the intermediate formation of ferrate, as the assumption may be made that the cell works continuously, in which case just as much ferrate is reformed by the oxygen fed to it as is decomposed by the current. Hence we have only to consider the reaction $2\ Na\ OH + C + O_2 = Na_2\ CO_3 + H_2O$. The heat developed by this reaction is 1240 K and, as it is computed for two equivalents of the electrolyte, gives the "theoretical" value of 2.66 volts for the electromotive force of the Jacques cell. In this case the water formed is supposed to be in the state of steam, and the assumption is made, although not quite justifiable, that the heat of the reaction calculated for the reacting substances in the solid state and at room temperature, is not essentially different at the temperature of the cell.

Moreover, a more careful consideration of the reaction shows that the action of the sodium ions which have migrated to the cathode upon the iron oxide or ferrate of iron, is to form, not sodium *hydroxide*, but sodium *oxide*. At the anode *two* molecules of water are liberated by the action of two hydroxlions on the coal and the sodium hydroxide. Hence the above computation would hold good only if the air blown in at the cathode contained a sufficient quantity of moisture to allow of the formation of sodium hydroxide instead of sodium oxide. I do not know whether this fact has been taken into consideration in the practical tests of the Jacques cell; at all events, I do not doubt that by the use of moist air, especially in the case of long runs, much better results might be secured.

As for the rest, it is a known fact that the energy of cells measured thermo-chemically is never fully transformed into electrical energy; there is always a positive or negative amount of heat left in the cell, which stands in a known relation to the temperature coefficient of the E. M. F.

As you perceive, my conception of the matter is, on the whole, in accord with Prof. Anthony's views, and as a matter of fact, I do not see the slightest difficulty in regarding the Jacques cell just like other electrochemical cell. The essential point in all cells is, that the oxidizing process which furnishes the required energy, shall not take place directly, but only through the agency of an electrolytic process. It is therefore necessary that the oxidizing agent should not be brought into contact with the oxidizable anode, but with a cathode as indifferent as possible. If the reacting substances are separated in this manner by an electrolyte, and the electrodes are metallically connected, the only way by which the chemical process can take place is for the oppositely charged ions to move in opposite directions until they reach the electrodes, where they lose their electrical charge. In this manner they react in the sense of the chemical reaction, and at the same time produce a current.

If one compares in this manner the Daniell cell, for example, with the Jacques cell, they will be found to be the same in principle. There is not the slightest ground present for the assumption made by Mr. Reed of any large unknown thermo-electric forces between metals and electrolytes. The forces developed in this case are known and have been measured (for instance by Bouty) and proved to be very small.

Leipzig, Germany. W. OSTWALD.

The Jacques Cell Discussion.

To the Editor of American Electrician:

The communication of Prof. Thomson in the December number of the AMERICAN ELECTRICIAN seems to do more than "clear the air" in the discussion of the theory of the Jacques cell. If his statements are correct, they clear the air of the Jacques cell itself, as a means of getting "electricity direct from carbon" and show that it is a means of getting electricity from potash or soda.

It seems that I have given Dr. Jacques credit for more than he deserves. All of my published statements regarding the Jacques cell have been directed to an explanation of the alleged results obtained by Dr. Jacques, on which some very sensational claims of obtaining "electricity direct from coal" and promises of revolution in science and industry were launched upon the public mind about two years ago. The statements of Dr, Jacques were denied by Mr. Fitzgerald in the London *Electrical Review* of July 3, 1896. As his denial was only a statement of his personal opinion, accompanied by no experimental evidence, I did not consider it competent to wipe out the positive and apparently corroborated assertions of Dr. Jacques, claiming to be based on exhaustive experiments on a very large scale. This denial is now affirmed by Professors Anthony, Thomson and Ostwald.

If the statements of Jacques were false, we have been discussing something that does not exist. Of more importance than theory is the question of fact, in which we have on the one side Dr. Jacques and his experts, on the other, the eminent authorities mentioned above.

In the spring of 1896 a description of the Jacques cell was published in a well known and very reputable electrical journal on the authority of Dr. Jacques, from which I quote as follows:

"In this process the carbon is gradually converted into carbonic acid, which mostly bubbles up through the electrolyte and escapes. The resultant composition of the electrolyte remains unchanged, except as shown below, and oxygen of the air is consumed.

"Although the greater part of the carbonic acid, whether resulting from the union of carbon and oxygen, or already existing in the air supply, bubbles up through the electrolyte and escapes, a portion of the carbonic acid combines with a portion of the caustic soda to form carbonate of soda, and this, together with the ash from the carbon, slowly contaminates the electrolyte, and in the course of time lessons its efficiency. The efficiency may be maintained by drawing off from time to time a portion of the contaminated electrolyte and admitting a fresh portion to take its place.

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*The active substance does not seem to be cupric oxide, CuO, but cuprous oxide, Cu_2O; this fact, however, is of no importance in the present case.

"The contamination of the caustic soda by its union with carbonic acid may be reduced and its life prolonged by adding a small percentage of the oxide of magnesium. According to Dr. Jacques the action of the oxide of magnesium is that the free carbonic acid combines with it in preference to the caustic soda, and that the carbonate of magnesium so formed is quickly decomposed into carbonic acid, which escapes, and oxide of magnesium which is again ready to repeat its action. Briefly, the oxide of magnesium serves as a carrier to convey the carbonic acid through the electrolyte."

These statements seemed to me at the time incredible, but a careful search of all the authorities at my command failed to reveal any direct contradiction. There was no authority for denying that magnesium oxide could act in the manner stated by Dr. Jacques at the temperature he employed, nor even for denying that at the high temperature employed alkaline hydrates would not combine readily with carbon dioxide. I had also been previously assured by a gentleman of unquestionable veracity and of the highest standing in the electrical fraternity, who had made investigations of the Jacques battery, that Dr. Jacques had found by analysis that the amount of carbon dioxide actually liberated corresponded exactly with the theoretical amount required by the current, and that the electrolyte suffered no apparent change after six weeks of continuous operation. In another article published by the authority of Dr. Jacques in the same paper a month after the one quoted above, occur the following paragraphs:

"The accompanying illustration (Fig. 2) shows a corner in Dr. Jacques' experimental laboratory. An early form of the carbon electric generator, which has now been in operation for six months, is seen to the left, the tops of the 100-cell battery showing with their connections * * * *. The cells consist of iron pots, 12 ins. deep and 1½ ins. in diameter.

"In a recent test made by Messrs. Stone & Webster, of Boston, the apparatus illustrated maintained 30 16-CP lamps at full brilliancy. It was found that to maintain these lights for 18¾ hours required the consumption in the pots, by oxidation, of about 8 lbs. of carbon. The average pressure during the test from the 100 cells was 90 volts, and the current 16 amperes. Messrs. Stone & Webster report that the electrical energy actually obtained from the carbon consumed in the pots was 82 per cent. of the theoretical."

It now appears, according to the authorities mentioned above, that these statements, instead of being statements of fact, were false, or at least, were cunningly devised for the purpose of deceiving the public as to the actual facts.

Who would have believed, from the statements quoted above, that no carbon dioxide is really given off in the Jacques battery? Who would have believed that each pound of carbon consumed required 9⅓ lbs. of caustic potash or 6⅔ lbs. of caustic soda? Why did not Messrs. Stone & Webster, in stating that 8 lbs. of carbon were consumed in furnishing 16 amperes at 90 volts for 18¾ hours, state that 75 lbs. of pure caustic potash or 50 lbs. of pure caustic soda were also required? Did it take Dr. Jacques and his experts more than six months of continuous operation to learn that the exhausted alkali removed from the pots weighed 12 or 15 times as much as the carbon consumed? Dr. Jacques in his illustration of a steamship (see *Harper's Monthly*, December, '96), showing how small a space would be occupied by his battery in comparison with that occupied by the steam plant, evidently forgot to show the increased size of the coal-bunkers, necessary to enable them to hold the caustic alkali that he would substitute for the coal.

The total energy evolved by the reaction,

$$2NaOH + C + O_2 = Na_2CO_3 + H_2O,$$

is 125,750 calories, and the corresponding reaction for potassium hydrate evolves 130,230. Stone & Webster's 82 per cent. efficiency was calculated on the supposition that CO_2, evolving 96,960, was formed, instead of Na_2CO_3 or K_2CO_3. The efficiency must, therefore, be reduced to 63 per cent. for caustic soda and to 61 per cent. for caustic potash. The total efficiency, instead of being 32 per cent., as given by Dr. Jacques, comes down to about 24 per cent. Mr. J. H. Helweg, Jr., has published the statement, which I do not think has been contradicted, that two-thirds of the electrical energy generated by the Jacques battery was required to operate the pump for forcing the air through the electrolyte. This is another small item that Dr. Jacques forgot to mention. If it is true, it brings down the net efficiency to 8 per cent., which compares favorably, so far as efficiency alone is concerned, with a steam engine using coal instead of caustic alkali for fuel.

Leaving now the question of efficiency for the more important question of commercial economy, we find that if the carbonate is formed, instead of the carbon dioxide, the battery ceases to have any possibilities. Its use would mean the displacement of a steam engine, using for each HP-hour one and one-half pounds of coal worth $3 per ton, by an apparatus using two and one-half pounds of caustic soda worth $60 per ton, in addition to .36 lb. of coal worth $3 per ton and .24 lb. of carbon in sticks worth at least $20 per ton. The comparison is, for raw material alone or fuel.

Steam engine................		.00225 per HP-H.
Jacques battery:		
Caustic soda	$0.075	
Coal	.00054	
Carbon	.0024......	.07794 " "

The raw material for the Jacques battery will cost at least thirty-four times that for a good steam engine and about seventy-five times that necessary for a gas engine. The weight of raw material to be handled for the Jacques battery is more than twice that used in the steam boiler, and the residue or "ash" from the battery would weigh ten or twelve times as much as that from the boiler. The figures are based on using 60 per cent. caustic soda, which would probably be the cheapest material that could be used.

The labor and expense of handling caustic alkali and keeping it in air-tight receptacles would evidently be greater than that of handling an equal weight of coal.

The figures given above assume also that all the caustic soda would be exhausted and that none would have to be drawn off until it was thoroughly carbonated. But it is evident from the nature of the apparatus that either the E. M. F. and efficiency would fall very low, or the alkali would have to be renewed before it became exhausted to any great extent, certainly before 50 per cent. of it could be utilized. Considering also the high temperature and rapid destruction of the apparatus, it is difficult to believe that this form of "electricity direct from carbon" could be practically obtained for less than about 100 times the cost of that obtained from steam, and it certainly could not compete under any conditions with a primary battery consuming zinc.

The theory of the reaction in this cell still possesses a certain scientific interest, though its possibilities for commercial or even for "promoting" purposes may be regarded as disposed of by the statements of Anthony and Thomson. The question of scientific interest is whether the chemical reaction within the cell, whatever it may be, is the cause or the result of the electric current, or in other words, whether the reaction could take place without the application and absorption of external heat.

The solution of this question depends altogether on the function of the oxygen forced into the cell. Without the energy evolved by the combination of that oxygen there is no possibility of galvanic action, the energy of carbon alone, without the absorption of external heat or electrical energy, being insufficient to decompose any constituent of the electrolyte. This fact has been brought out so often in this discussion that I shall not repeat the evidence, but refer to the recent issues of the AMERICAN ELECTRICIAN, particularly to the issue of August, 1897. Prof. Anthony has claimed that this injected oxygen acts as a depolarizing agent, that is, that it is one of the reagents taking part in the electro-chemical reaction and that the energy of its combination is given to the electric circuit as electrical energy; that this is the source and the only source of electrical energy. As evidence in support of this position, he refers to no facts, but to an alleged analogy, which he has repeatedly asked me to explain; while he has with equal pertinacity overlooked as immaterial, the most pertinent and important facts.

The object of scientific research and discussion is not to explain analogies, real or imaginary, but facts. It is for this reason that I have not thought it necessary to fill the columns of the AMERICAN ELECTRICIAN with explanations of analogies that have no real existence, hoping Prof. Anthony would ultimately come to a consideration of the facts.

It is a fact that the substitution of a rod of iron for the carbon rod in the Jacques battery gives a higher E. M. F. than can be obtained from the carbon. In that case we have two iron electrodes in contact with a fused electrolyte; one is continually receiving heat from the electrolyte, one is continually imparting heat to the electrolyte. This apparatus, without the introduction of air or oxygen, gives between the two iron electrodes an E. M. F. of 1.2 volts, and maintains it indefinitely, so long as the temperature is maintained. I will now request Prof. Anthony or Prof. Ostwald to state where this energy comes from, if it is not derived from the heat of the furnace, and how it is converted into electrical energy if not by thermo-electric inversion? It seems to me this question is sufficiently specific and definite to be entitled to a specific answer, not a parable or an analogy, but an assertive answer. Is this energy derived from the furnace or not? Until this fact is explained in some other way than by thermo-electric action, the statement by Prof. Ostwald in another column that "there is not the slightest ground present for the assumption made by Mr. Reed of any large thermo-electric forces between metals and electrolytes" would seem to be premature.

As to the "analogy" cited by Prof. Anthony of the zinc and platinum electrodes immersed in dilute acid, the observation that air coming in contact with the platinum increases the E. M. F., is correct; but the inferences and analogies that were drawn from this fact were erroneous. The inference that this increase in E. M. F. is due to the oxygen of the air "combining directly with the positive ion of the electrolyte" or "acting as a depolarizer" is incorrect. The experimental proof on this question is absolute. The only oxygen that acts as a depolarizer or takes part in the electro-chemical reaction is that which is evolved from the platinum and has been chemically combined with it in the form of a solid—oxygen that has given up combustion heat in being absorbed by the platinum. This fact may be easily demonstrated by substituting for the platinum a piece of carbon, which absorbs oxygen without combining with it. Prof. Anthony will find that with a carbon electrode, instead of platinum, the current of air produces absolutely no depolarizing effect. There is another effect that is sometimes mistaken for a depolarizing effect. It is the mechanical effect of reducing the resistance by shaking off bubbles of hydrogen gas. This effect is produced equally well by shaking the electrode, by a current of air or by a current of nitrogen or any other inert gas. If the carbon electrode be thoroughly shaken, being at the same time entirely covered by the solution, the E. M. F. will be the same, whether the current of air is employed or not. But this not the case with a platinum electrode, because platinum, as has been pointed out by Berthelot, has the power of combining with the oxygen and evolving heat of chemical combination. It is the decomposition of this compound that yields the only oxygen which takes any part in the electro-chemical reaction of Prof. Anthony's analogy-cell. That the current of oxygen has no effect whatever on the electrolyte is evident from the entire absence of depolarizing effect when carbon is used instead of platinum. The same thing may be shown also by using a well amalgamated sheet of silver, lead or copper instead of the platinum. If the oxygen acted on the electrolyte directly, as claimed by Prof. Anthony, it could make no difference whether the electrode be of platinum or not. The depolarizing effect would be the same in all cases.

Returning now from these analogies to the question at issue, the reaction of the Jacques cell, we find an amusing assortment of contradictions between authorities, which would require a tabular index for their complete enumeration.

Prof. Ostwald states in one place that the function of the oxygen is to re-oxidize the reduced iron, and that the energy of this reaction is lost so far as any electrical process is concerned. This is exactly my view and the one I have been trying for two years to establish. He then abandons that position and calculates the E. M. F. as due to the combination of this oxygen with carbon and sodium, taking particular pains to say that he agrees with Prof. Anthony.

Prof. Anthony holds that the "oxygen combines with the positive ion of the electrolyte in strict accordance with Faraday's law, and is the medium by which the current reaches the iron electrode and passes out of the cell." He believes that bubbles of oxygen that happen to strike the iron electrode enter into combination with the electro-positive ion of the electrolyte and give their energy directly to the circuit; that the oxygen "by combining with the positive ion of the electrolyte furnishes exactly the energy needed for the decomposition of the electrolyte." He consistently adheres to this delusion.

Prof. Thomson formerly stated as the result of experiments, that the function of the oxygen is to re-oxidize reduced iron. He now for some unexplained reason abandons this view and says it seems to combine directly with the carbon, and that its action is the same whether the current is flowing or not. Prof. Anthony on this point agrees with Dr. Jacques and says the oxygen used is proportional to the current.

Prof. Ostwald begins with the statement that the reaction is like that of the Lalande battery, the carbon taking the place of the zinc and the ferric oxide taking the place of the copper oxide, the electrolyte being sodium hydrate in both cases. The reaction in the Lalande battery is

$$Zn + 2NaOH + CuO = Na_2ZnO_2 + H_2O + Cu, \quad \ldots \ldots (2)$$

and that of the Jacques battery,

$$3C + 6NaOH + 2Fe_2O_3 = 3Na_2CO_3 + 3H_2O + 4Fe \quad \ldots \ldots (3)$$

These two reactions are, as Prof. Ostwald says, strictly analogous. In each case an element is oxidized by oxygen that comes, not from the air, but from the decomposition of a metallic oxide and the reduction of a metal to the metallic state, the reduced metal in the Lalande battery being copper, and in the Jacques battery, iron. The similarity of the two reactions is perfect and there is no free oxygen concerned in either of them, none appearing in either equation. The rôle of each constituent cannot be better described than in the words of Prof. Ostwald, the function of the air or oxygen being, as he says, "*the renewal of exhausted ferric oxide*," a subsequent reaction. In other words, its function is the re-oxidizing of reduced iron in exactly the same manner as the re-oxidizing of reduced metallic copper "*by exposing the plate to the air, thus permitting the porous copper to be oxidized.*" These reactions (2) and (3), are undoubtedly the electro-chemical reactions corresponding to the passage of the current in the Lalande and Jacques cells, respectively. It is further evident, as explained by Prof. Ostwald, that the Lalande "cell becomes exhausted as soon as one of the three substances, zinc, copper (oxide) or sodium hydrate is missing," and that in the Jacques battery the cell becomes exhausted as soon as any one of the substances, carbon, ferric oxide or sodium hydrate is missing. But as long as none of these substances is missing. the action goes on and there is no need of oxygen. And it is a fact that the E. M. F. is produced and maintained indefinitely whether any oxygen is employed or not, and even when any inert gas is substituted for it, the oxygen being needed only after sufficient current has passed to exhaust the ferric oxide present.

These reactions being accepted, a most remarkable question injects itself into the discussion at this point, viz., *what has the renewal of exhausted material by a subsequent and independent reaction to do with the electro-chemical reactions in these batteries?* If the exhausted material from these batteries were thrown away (as it generally is in the Lalande battery and as it seems to have been in the Jacques battery) and replaced by new material, instead of being re-oxidized, in what manner would that alter the reaction of the battery? It has never been claimed that this has anything to do with the reaction of the Lelande battery. Why, then, does the reaction of the Jacques cell depend upon the subsequent disposition of the by-products, whether they are regenerated within the cell or outside of the cell or not at all?

Is it possible that such an impertinent question as this has brought confusion upon our greatest authorities? Is it credible that Prof. Ostwald, after so clearly and admirably stating the electro-chemical reaction in the Jacques cell to be the reaction between the carbon, ferric oxide and sodium hydrate, and after also stating in unmistakable terms that "the energy which is set free by the union of the oxygen with the copper or iron is lost as far as the electrical process is concerned" and that the office of the injected oxygen is "the renewal of the ferric oxide," should precipitately abandon his position and say "we have only to conside the reaction

$$\text{"}2NaOH + C + O_2 = Na_2CO_3 + H_2O\text{"?}$$

And he says this because "the cell works continuously." *What has the continuous operation of the cell or the renewal of ferric oxide to do with the cause of the E. M. F.?* I can explain this confusion only on the ground that there is some great mistake in the translation of Dr. Ostwald's letter. In calculating the theoretical E. M. F. from this last equation a numerical error has also crept in, which is entirely excusable when we conconsider the very short time Dr. Ostwald was able to give to the preparation of his communication. The value obtained from the thermal equivalent, 124,000, is 1.33 volts instead of 2.66, carbon being a tetrad in this reaction and being electro-chemically equivalent to four atoms of hydrogen or two of oxygen.

Assuming that the regeneration of exhausted material has nothing to do with the cause or seat of E. M. F. in either the Lalande or the Jacques cell, and that the reactions in these cells are those given by Prof. Ostwald in the earlier part of his communication, we are now in a position to determine whether the reaction in the Jacques cell is galvanic or electrolytic, that is, whether the electrical energy is derived from the chemical reaction, or the chemical reaction, a result of electrolysis caused by a thermo-electric current.

Referring again to equations (2) and (3) above, we find that while they are exactly alike as far as the nature of the reaction is concerned, they differ in one important particular, viz., the energy concerned in the reaction. The reaction in the Lalande battery evolves energy (about 40,000 units), but the reaction of the Jacques battery absorbs energy instead of evolving it. It cannot take place without absorbing energy, and the only form of energy present to be absorbed is heat.

The following formation-heats are taken from Naumann's "Lehr-und Handbuch der Thermochemie:"

$$\begin{array}{lr} Na,\ O,\ H & = 102{,}030 \\ Na_2,\ O_2,\ \ C,\ O & = 271{,}080 \\ H_2,\ O\ \ \text{(as gas)} & = 58{,}700 \\ Fe_2,\ O_3 & = 191{,}130 \end{array}$$

We have, therefore, in the reaction of the Jacques cell from (2) the thermal relation,

$$3C + \left\{\begin{matrix} 6 \times 102{,}030 \\ 6NaOH \end{matrix}\right\} + \left\{\begin{matrix} 2 \times 191{,}130 \\ 2Fe_2O_3 \end{matrix}\right\} =$$

$$\left\{\begin{matrix} 3 \times 271{,}080 \\ 3Na_2CO_3 \end{matrix}\right\} + \left\{\begin{matrix} 3 \times 58{,}700 \\ 3H_2O \end{matrix}\right\} + 4Fe.$$

The sum of the formation-heats of the reagents (first member of the equation) exceeds the sum of the formation-heats of the products (second member of the equation) by 5100 units; and, therefore, that amount of energy must be absorbed or the reaction cannot take place. This is 1700 units for each of the three atoms of carbon oxidized in the equation, or a counter E. M. F. opposing the oxidation of the carbon, equal to

$$\frac{1700}{4 \times 23{,}260} = 0.019 \text{ volt.}$$

In all my previous published statements on this subject I have, in deference to the claims made by Dr. Jacques, assumed the reaction to be without the formation of carbonate, the equation being

$$3\,C + 2\,Fe_2O_3 = 3\,CO_2 + 4\,Fe.$$

If this were the reaction, the counter E. M. F. opposing the oxidation of the carbon would be about 0.3 volt, instead of 0.019 volt. In either case the electro-chemical reaction cannot take place without absorbing energy. In other words, the electro-chemical reaction is electrolysis and is caused by the electric current to which it corresponds. As the only source from which energy could be absorbed in this cell is heat, the current must comfrom thermo-electric inversion, there being no other known process by which, under the circumstances, heat can become electrical energy.

I have also found experimental proof of the correctness of this theory in a Jacques cell constructed of pure silver, instead of iron. The results were entirely different from those obtained with iron. The details of this experiment will be published later. It will be sufficient to say here that with the silver apparatus and pure caustic soda, metallic sodium was given off from the walls of the crucible and burned with explosive reports in twelve minutes after the circuit was closed, and the crucible had become alloyed with metallic sodium. The liberation of metallic sodium increased from that time until the end of the experiment, notwithstanding the fact that a strong blast of air was injected through a silver tube into the electrolyte. At the end of twenty minutes the potential of the cell had fallen to zero and reversed. In thirty minutes after the closing of the circuit the explosions from the combustion of metallic sodium became so violent that the operation had to be stopped, and the room (a large one) was filled with a white cloud of dust of sodium oxide. The crucible was 1½ ins. in diameter and 3 ins. deep. The carbon rod was ¼ in. in diameter. The lower part of the crucible was found to be so thoroughly impregnated with metallic sodium, that it became spongy on washing with water. Water which was afterwards allowed to stand in it soaked through it in twenty-four hours, as it would through porous earthenware. On slight pressure the bottom of the crucible crumbled to powder resembling a brittle amalgam of zinc.

The reduction of sodium requires a much greater absorption of energy than that of iron, and its reduction cannot be explained on any theory except that of absorption of heat and the agency of a powerful thermo-electric current.

It does not follow from this that the efficiency of the apparatus is low. On the contrary, as has been previously shown, the efficiency may be very high, certainly as high as anything that has been obtained from the Jacques cell, according to such reports as are worthy of belief.

Philadelphia, Pa. C. J. Reed.

NOTES.

Patent Office Knowledge.—Mr. James Swinburne states in a recent article that an application for an American patent for a transformer system by Bernstein, was refused on the ground that one cannot possibly get "more current out of a machine than you put in it"!

Compound Dynamos and Their Action.—In an article under this caption which appeared in our December issue, credit should have been given to a paper by Prof. W. L. Puffer, printed in the *Technology Quarterly*, of December, 1892, for much of the matter contained in the article, as well as for one of the cuts. Prof. Puffer's paper deals in an original and exhaustive manner with the action of compound dynamos when run in parallel, and we regret that proper credit was not given for the large amount of matter extracted verbatim from it.

Large Storage-Battery Plants.—The Chicago Edison Company has placed an order with the Electric Storage Battery Company for a storage-battery plant of 7436 KW-hours, which will be the largest battery installation ever made. The Buffalo Railway Company has also ordered from the same company a battery which will be the largest ever installed for railway service. By means of this storage-battery installation, the Buffalo Company will be enabled to take full advantage of its twenty-four-hour contract for Niagara power.

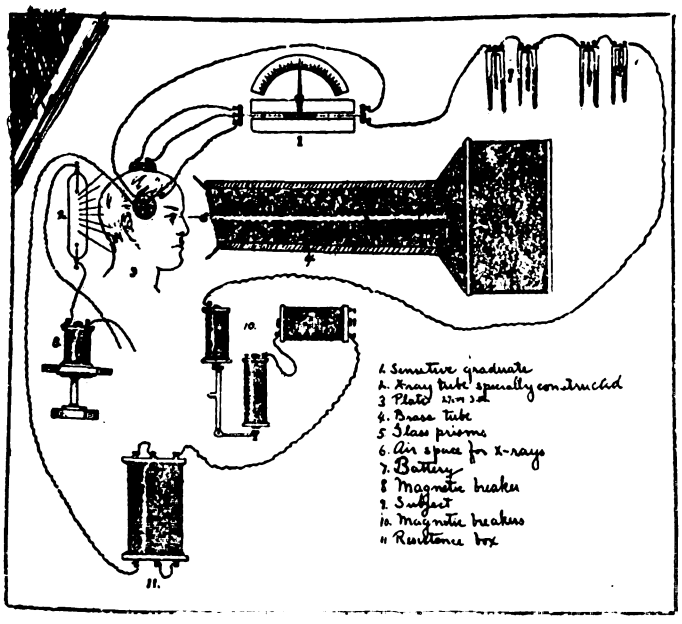
The Trans-Mississippi Exposition.—The Trans-Mississippi Exposition, which will open its gates at Omaha, June 1, of next year, and continue five months, is daily adding to the list of attractions. The many buildings to be erected will vie in architectural beauty with those of the World's Fair, and the Electricity Building, illustrated recently in our columns, is one of the most imposing. More than forty conventions are already booked to be held at Omaha during the exposition, and it is to be hoped that among the many additions that will doubtless be made to the list, the general meeting of theAmerican Institute of Electrical Engineers may be included.

Water Power Development in the West.—Among recent electrical water plants developed in the West is one of 3000 HP, about 8 miles from Tacoma, the available head of water being 115 ft. The electrical energy developed will be transmitted at a voltage of 10,000. Though the electrical machinery is not yet installed, almost the entire capacity of the plant has been contracted for, in amounts ranging from 100 to 500 HP. A water-power electrical plant of some 3000 HP has recently been developed in Montana, about 30 miles distant from Butte. The demand for current has been greater than the entire capacity of the plant when completed, and many applications for power had to be refused.

International Health Exposition.—At the International Health Exposition to be held at the Grand Central Palace for five weeks beginning Apr. 25 next, there will be a department of electricity in which will be shown the applications of electricity to health and sanitary matters and as an aid to household economies. Mr. Luther Stieringer, consulting electrical engineer of the World's Fair, Atlanta, Nashville, and Omaha Expositions, has been retained in a similar capacity for the International Health Exposition. Mr. Nikola Tesla will make a personal exhibit, and will show for the first time some novel apparatus designed for the cure of certain diseases, which will be submitted to the medical profession for critical examination, and also communicate his views as to some of the possibilities of electricity in the prevention of disease and the prolongation of human life. The phonograph will be shown in applications with which the public is not familiar, not as a toy, but as a scientific instrument which only needs to be understood to be a necessity in every well equipped specialist laboratory.

The Northwestern Electrical Association. The sixth annual convention of the Northwestern Electrical Association will be held at the Hotel Pfister, Milwaukee, commencing on Wednesday morning, Jan. 19, next. Direct and alternating current will be provided for exhibits. Papers on "Practice of Theory," "Present Efficiency for Incandescent Lamps," "Notes on Municipal Ownership," "Physical and Chemical Properties of Volatile Oils in Boilers," "Electric Lighting for Profit," "Long-Distance Transmission," and "Transformers," will be presented by John C. McMynn, of Illinois; John E. Randall, of Missouri; Fred DeLand, of Illinois; Wm. H. Edgar, of Illinois; Alex. Dow, of Michigan; Axel Ekstrom, of New York, and E. H. Abadie, of Missouri.

A New Wizard.—The sensational newspaper press is delighted at the discovery of a new electrical wizard in the person of Thos. A. Edison, Jr., the son of the original "wizard." Doubtless the sight of the columns of matter of which he is at present the subject will bring many heart-burnings to the old established "wizards," now in great danger of suffering eclipse. Within a month the new aspirant to wizard honors leaped into a fame scarcely attained by years of patient labor by the aforesaid "old established"—first as the inventor of a new incandescent lamp, and then as the discoverer of a method of photographing thought. The apparatus for thought photography is described as a closely fitting chemical bandage for the head, "whose properties are of a chemical combination, which is a jealously guarded secret; " leading from the temples and the suture of the skull are delicate conductors charged with some secret chemical to carry the most minute vibration, to which conductors are attached a graduate of secret properties and a series of disks which register the vibrations; finally, there is an X-ray apparatus, but this is of the ordinary kind and without secrets. A subject being secured, the young wizard commands him to concentrate his thoughts on some object, such as a silver quarter—but we will allow the newspaper reporter to graphically describe the process. "'Think of a quarter,' shouted Edison, Jr., 'a bright new quarter. It is to be yours.' As he spoke he whipped off the secret bandage, thrust the subject into place for the X-rays, and sent them through his brain, into a long, dark box fitted with prisms, thence to the film. Trembling with expectancy, he withdrew the film. There on the secret surface, as he tells it, was plainly discernible a round ring 18 ins. in diameter—the film was 2½ ft. × 3 ft.—and around the edge of the ring was a series of thirteen blurs like the stars which encircle the Goddess of Liberty on a quarter." The accompanying illustration (from the New York *World*) is reproduced from a sketch furnished by young Edison.



REPRODUCTION OF AUTOGRAPHIC DIAGRAM.

Niagara Power. The power-transmission line from Niagara Falls to Buffalo will shortly be doubled in capacity by the addition of three more wires. Seven new General Electric transformers will be installed, of similar size and design to the three already in the transformer house of the Niagara Falls Power Company. These ten transformers, which are of the air-blast type, are the largest ever built, each having a capacity of 1250 HP. The two-phase currents from the 5000-HP generators which are generated at 2200 volts, will not only be increased in pressure in these transformers, but changed in phase, issuing as three-phased currents at 11,000 volts. The design of the transformer is such that this voltage can later be increased to 22,000 volts. Several step-down transformers will also be placed in the station of the Buffalo General Electric Company, and from these three-phase currents will be converted into direct current by means of rotary converters, and utilized for lighting purposes and for small power units. The Buffalo Railway Company is also increasing its step-down transformer and rotary-converter capacity. In addition to the two 500-HP converters already in use, the General Electric Company has built two others of similar capacity and construction, which will bring the total converter capacity in the station up to 2000 HP. To provide for these additions, three more step-down transformers have been installed. These will be the same capacity as the three already there, each of 275 KW, reducing three-phase currents from about 10,500 volts to 375 volts for delivery to the alternating-current side of the rotary transformer, in order that it may issue at 550 volts direct current. 24,000 ft. of cable has been ordered from the General Electric Company, which will be the first used for that part of the transmission line which is within the limits of the city of Buffalo. This cable is of special manufacture, and insulated to stand the ultimate pressure of the line, which will be 22,000 volts.

Electrical Journals of the World.—A French contemporary recently printed a list of the electrical journals of the world, with date of establishment. Though quite incomplete, this list comprises 58 publications, of which 20 are printed in French, 20 in English, 10 in German, two each in Spanish, Italian and Dutch, one in Russian and one in Japanese. The oldest in date of establishment is the French *Annales Télégraphiques*, publication of which was commenced in 1858. The second in date is the American *Journal of the Telegraph*, established in 1867, as the successor of the *Telegraph Journal*, concerning which latter publication no information has been obtainable. The third in point of seniority is the London *Electrical Review*, which recently celebrated the twenty-fifth year of its existence by the issue of a magnificent commemorative number, dated Nov. 12, 1897. Eleven journals are given in the American list, of which one appears under two titles, and two are no longer published. We give herewith what is believed to be a complete list of American journals, in which are included the two street railway journals, since they now practically deal only with electric railways.

1867 (Dec. 2).—*Journal of the Telegraph.* Monthly. New York.

1883 (March 22).—*Electrical Review.* (Feb. 15, 1882, *Review of the Telegraph and Telephone.*) Weekly. New York.

1883 (April 28).—*Electrical World.* (Jan. 1, 1874, *Operator;* Jan. 6, 1883, *Operator and Electrical World.*) Weekly. New York.

1883 (June 1).—*Telegraph Age.* Semi-monthly. New York.

1884 (Jan.).—*Street Railway Journal.* Monthly. New York.

1884.—*Transactions of the American Institute of Electrical Engineers.* New York.

1885 (Aug. 1).—*Railroad Telegrapher.* Monthly. Peoria, Ill.

1886.—*Pacific Electrician.* Monthly. San Francisco.

1887.—*Western Electrician.* Weekly. Chicago.

1888 (Jan. 1).—*Electrical Engineer.* (*Electrician*, Jan. 1, 1882; *Electrician* and *Electrical Engineer.* Jan. 1, 1884.) Weekly. New York.

1891 (July 22).—*Electricity.* Weekly. New York.

1891.—*Electrical Age.* (1883, *Telegraph Age*). Weekly. New York.

1891 (Jan.)—*Street Railway Review.* Monthly. Chicago.

1892.—*Electrical Worker.* Monthly. St. Louis.

1893 (June).—*Electrical Engineering.* (*World's Fair Electrical Engineering*, Jan. 1893). Semi-monthly. Chicago.

1895 (July).—*Journal of Electricity.* Monthly. San Francisco.

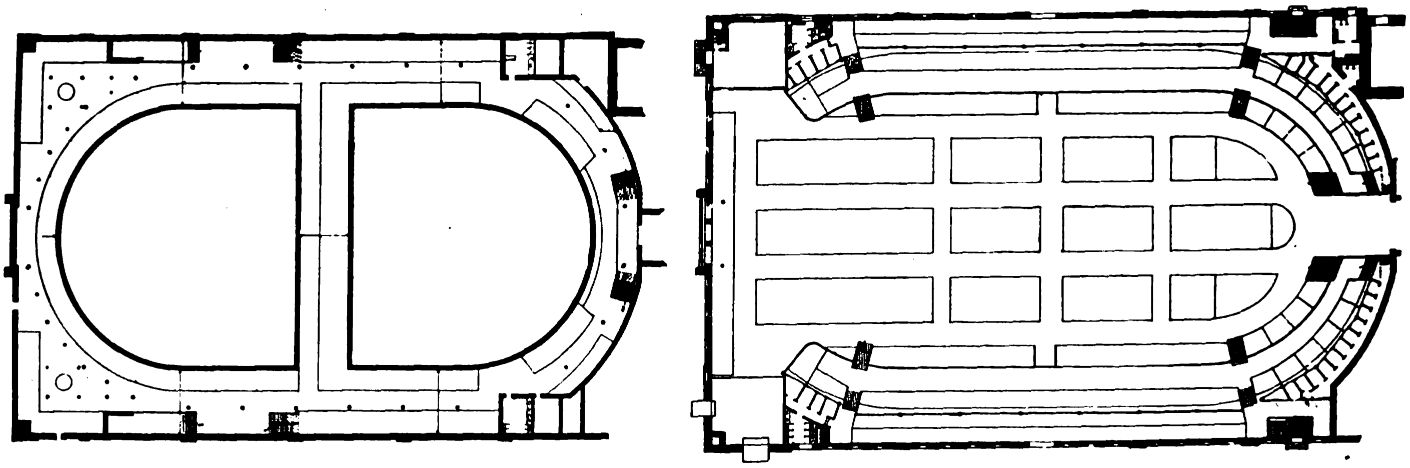
1896 (May).—*American Electrician.* (1889, *Electrical Industries*). Monthly. New York.

1896 (March).—*The Telephone.* Monthly. Chicago.

The date prefixed is in each instance the date of the first issue under the present name. In order, however, to avoid any occasion for re-opening the battle of the "Oldest," the date of establishment is also given of the publication which is claimed as a lineal predecessor.

Underwriters' National Electric Association.—At the annual meeting last month of the Underwriters' National Electric Association, it was voted that the break-down test of insulated wire should be of five minutes' duration, but the matter was referred to the American Institute of Electrical Engineers with a request that they express an opinion as to the propriety of this time limit. A table was reported with break distances for knife switches, up to 600 volts. The general subject of the construction of incandescent lamp sockets was referred to a committee of three, with instructions that specifications be drawn up, with which approved sockets should comply.

New York Electrical Exhibition.—The electrical show to be given in New York during the month of May promises to even exceed the phenomenal success of the 1896 show. Much of the space is already taken, in many instances exhibitors at the last show taking double or more the space they occupied in 1896. As the exhibition will be held in Madison Square Garden, it will be subject to comparison with the bicycle and other very successful exhibitions, and the electrical fraternity owes it to itself that the comparison shall not be unfavorable. Though necessarily held under the auspices of a private management, the object of the exhibition is a laudable one. Those in charge are animated more by a desire to "boom" the electrical industry than by thought of pecuniary gain, and deserve the good wishes of all for a brilliant success.



OPERATIVE EXHIBITS. NEW YORK ELECTRICAL EXHIBITION. MAIN FLOOR.

Electricity Direct from Heat.—In a recent communication to the French Academy of Science, M. Marcel Deprez promises to presently announce a method of utilizing in a practical way the magnetic properties, lately discovered by M. Guillaume, of certain alloys. A 30-per cent alloy of nickel with iron, was found, for example, to be strongly magnetic at 112 degs. Fahr., and to lose completely its magnetism at 212 degs. By the second law of thermo-dynamics, in any practical application which M. Deprez may make of this property, only 13 per cent of the heat supplied can be utilized at perfect efficiency—which is less than the percentage of heat that can now be transformed into electricity by means of a boiler, and the most efficient types of steam engines and dynamos. The working efficiency of such an arrangement must be necessarily small, and also its activity or rate of doing work, thus necessitating an extremely large apparatus in comparison with a steam engine of the same power.

Resistances in Early Days.—In a recent article Mr. W. M. Mordey says he remembers using, about 1871 or 1872, resistance coils of a few thousand ohms, weighing certainly more than 30 lbs. They were made of copper wire of quite large diameter, and required to carry, perhaps, a full load of possibly one watt. He also remembers that the mystic letters, "OHMS" on these coils were currently understood to mean "On Her Majesty's Service." The first superintendent of a cable station used to relate how, at an earlier date, in making insulation tests, the resistance in the balancing arm of a Wheatstone bridge was recorded in feet of iron wire and lengths of steel hoop-skirt, the latter being used for finer adjustments.

A Quarter-Century of Electrical Journalism.—Our very highly esteemed London contemporary, *The Electrical Review*, celebrated the twenty-fifth year of its existence by the issue on Nov. 12, of the best number of a purely electrical journal ever printed. The June, 1897, number of the AMERICAN ELECTRICIAN, had previously held the record, but we resign that claim in favor of our English contemporary, and offer our congratulations on its splendid enterprise, together with our heartiest wishes for the continuance of its prosperity. The eighty pages of reading matter are principally occupied by retrospective views of progress in the electrical field during the past twenty-five years. No less than twenty-two separate articles of this character appear, covering together every branch of electrical science and industry, each written by an authority in the department considered. It is to be hoped that these articles will be gathered into book form, as they furnish a most interesting and valuable epitome of the period covered—a period, moreover, which has witnessed the birth of the great majority of the branches treated.

The Heilmann Locomotive.—Our Paris correspondent sends us a description of the latest type of the Heilmann locomotive, which is now undergoing trials in France. The locomotive proper has a length of 59 ft. and is provided with an ordinary type locomotive boiler, a Willans compound engine of 1500 HP, direct-connected with two 6-pole Brown generators, of 450 KW each at 500 volts and 400 r. p. m. The generators are excited by a small 4-pole dynamo, giving 140 amperes at 110 volts and 550 r. p. m., driven by a small Willans engine. The current generated drives eight motors, each mounted on an axle of the locomotive. The total weight of the locomotive alone is 120 tons, and that of the tender 49 tons, making a total of 169 tons. This central station on wheels has been designed to draw trains up to 300 tons, and at speeds up to 62 miles per hour.

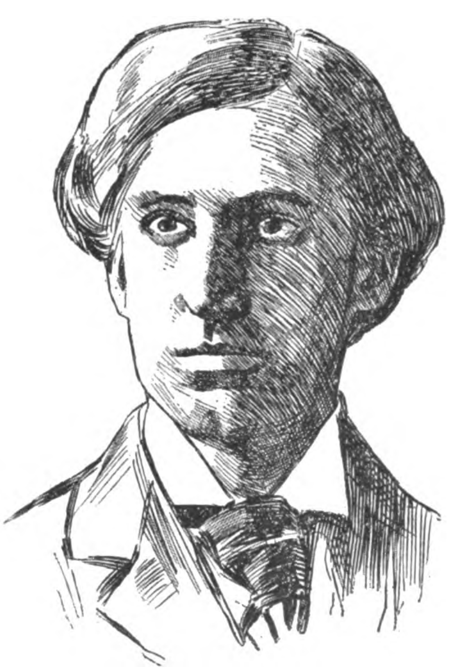
Electro-Chemistry as a Profession.—In the London *Electrical Review*, Mr. Emile Andreoli says that anyone who a few years back would have recommended a young fellow to take up electrolysis as a profession, would have been considered to be a bit eccentric, or even not to be quite right in his head. There was then, he says, hardly any future for anyone in that field, for, apart from galvanic metallic deposition, no electro-chemical industry existed. Even now, it is, of all the branches of electricity, the least encumbered, but the one in which a young man has the best chance of securing a good position. Mr. Andreoli adds, however, that he will not make much progress if, although a good electrician, he is but a poor chemist; but it will be the very opposite, he thinks, if, being a good chemist, he has no very great acquirements in electricity. Electrolysis and electro-metallurgy, he considers are, nowadays, professions in themselves. Not only are there electro-chemists and electro-metallurgists to be found at the present time, but there are also consulting engineers who confine themselves to electrolytical matters, experts who make it their special business to draw up reports on new methods, or to give advice as to the best means of applying them. Who, he concludes, even ten years ago, could have foreshadowed this state of affairs?

A Discovery Rediscovered.—The daily press has lately devoted considerable space to the alleged discovery by a Western jeweler of a method of transmitting pictures by telegraphy. As described, the process appears to be identical with the Bakewell-Caselli facsimile process, invented more than a quarter of a century ago. At each station is a synchronous mechanism, the receiving instrument duplicating the movements of the sending instrument. The picture to be transmitted is so prepared that a tracing-point at the sending end passes alternating over a conducting and a non-conducting surface, the receiving tracing point making a mark when on the former. In practice, the picture is so redrawn that the conducting surfaces are in the form of straight lines, representing in hatching the original. These lines are reproduced by closely spaced dots, which gives a semblance of the original picture in hatch-work. Gray's telautograph is a vastly more perfect facsimile device, as it reproduces continuous lines—in fact, being capable of making exact reproductions in full lines from unprepared copy, the receiving-point following the transmitting point in all of its motions as if it were one arm of a pantograph, the sending-point being the other arm.

Municipal Electrical Inspection.—At the annual meeting last month of the Underwriters' National Electrical Association, the subject of most general interest that came up for discussion related to reported departures from the National Electrical Code, of municipal codes for electrical inspection. In New York, for instance, a code is under preparation differing very materially from the National Code, and a committee of the association was appointed to confer with the municipal department on the subject. The National Code was prepared by delegates from the American Institute of Electrical Engineers, National Electric Light Association, Underwriters' National Electric Association, American Society of Mechanical Engineers, American Street Railway Association, American Institute of Architects, National Board of Fire Underwriters, National Association of Fire Engineers, and Factory Mutual Fire Insurance Companies, assisted by Kennelly and other recognized authorities. Municipal authorities who consider that they can improve upon the labors of such as these, and who are not content with fire protection that meets with the official approval of all underwriters, certainly do not lack assurance. Municipal inspection should, under any circumstances, be discouraged so far as relates to interior electrical work. The great interests the underwriters have at stake assure much more efficient inspection than can be expected from the usual city employe; and if, in addition, electrical contractors are to be harassed by having to comply with arbitrary code compilations of city electricians, a superfluity becomes an evil, which may develop into an intolerable one through the intrigues of politicians.

The Walker Company.—An important change has taken place in the ownership of the Walker Company, which recently passed into the hands of four men well known not only in the financial world, but also in public life—Ex-Governor Roswell P. Flower, Major J. W. Hinckley, Perry Belmont and Anthony N. Brady. Aside from the strength of the company financially under its new ownership, the fact that these gentlemen represent together electric railway interests aggregating $100,000,000, implies an assured market of no mean proportions for its manufactures. Prof. S. H. Short, remains as technical chief, which assures a continuance of the high standing of Walker apparatus. The growth in favor of Walker apparatus during the past few years has been so rapid, that at the present day its manufactures stand in reputation second to none, the name Walker being on a plane with that of the greatest of the electrical manufacturing companies, at home and abroad. This success has undoubtedly been largely due to the ability of Professor Short as a designer, coupled with a long experience in the electrical field, which has made him thoroughly conversant with all the practical and commercial problems involved in the production of electrical machinery. The new Walker alternator may be pointed to as an example of this union of qualities, the introduction of all the latest principles of alternating-current machinery design in this case not meaning an experimental apparatus, but a commercial machine fitted when placed on the market, for all the demands of practical service, however varied or severe. With its present strong financial backing, and with the technical policy of the old company continued under the new management, there is every promise of a development that will make the Walker Company an increasingly great factor in the electrical field.

Edison, Jr.—The son of Edison has entered the electrical field as an inventor, the first evidence of his inherited talent being an incandescent lamp, called the "Thos. A. Edison, Jr." which is claimed to be the most economical lamp thus far made. The filament, which is of the coiled type, differs in shape from other coil filaments in having three loops with a straight common axis. The young inventor, who has just attained his majority, says that to improve the incandescent lamp as he found it was necessary to increase the candle-power and efficiency, and also use a much higher vacuum in exhausting. To accomplish these ends without increasing the cost, he invented a new form of air pump, and uses a filament made of a chemical combination carbonized at 4000 degs. Fahr. The inventions and processes involved in the manufacture will not be patented, the young man believing that a patent furnishes no real protection.



Thomas A. Edison Jr

Transformers and Theorists. — Mr. James Swinburne, though considerable of a theorist himself in a non-mathematical way, has little use for theorists who deal in symbols. Writing of the transformer in the London *Electrical Review*, he says that by the time that apparatus was practically thrashed out and in general use, it was time for "so-called theorists" to tackle the subject. "Everyone, from those who just knew how to differentiate the sine and cosine with respect to the angle, up to some of the ablest mathematicians of the day, seems to have turned himself loose on the subject. The victim was attacked from two sides; one section of the invading force made clock-face diagrams, which were so absurdedly wrong in scale that they give no idea of what goes on in a transformer; and the others attacked it analytically, and wrote strings of equations. The transformers that were subjected to attack by analytical methods, generally had resistances, R and r, and self-inductions, L, and sometimes, L', and even mutual induction, M. They seldom had all these recommendations at once, and even now people will talk about the "self-induction of the transformer." I remember as late as 1890 trying to explain to a pure theorist that the transformer designers did not work in that way, and that none of my assistants would know what the self-induction of a transformer was. He said 'it is a shocking state of things.' So it was, but I do not know even yet what the 'self-induction of a transformer' is, and I fear I never will know. All these calculations, geometrical not to scale, and analytical with letters instead of numbers, have been almost absolute waste as far as information goes. They occupied a great deal of room in the technical papers, often involved very advanced mathematics, were generally considered very deep and learned by those who did not take the trouble to see what they were all about, and they must have been very expensive to print. The yearning for publishing elaborate calculations on insufficient or wrong data seems to be almost a disease. It is going on still." Referring to an investigation he made, which was later confirmed by Prof. Ryan, showing that the magnetizing current could not possibly vary harmonically—this, he says, "did not daunt the attacking force a bit, but only gave them more to work upon, for they seized upon Fourier's series and have reveled in it ever since. There are still papers and books coming out on the so-called theory of alternating currents, and multiple-current work has given it a new lease of life lately. As far as I known, it has never had the least influence on the design or manufacture of any practical electrical apparatus." Mr. Swinburne qualifies his remarks by saying that he does not mean that engineers do not make use of a certain amount of calculation involving harmonic currents and pressures, but that the elaborate and complicated calculations of theorists, with letters instead of figures, or diagrams not to scale, have been practically waste paper.

ESTABLISHED 1889.

American Electrician,

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Electrital Industries.

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Diagrams of Electrical Connections.

Beginning with this number, subscribers to the AMERICAN ELECTRICIAN will receive with each issue a supplement, consisting of a sheet of diagrams of electrical connections. The matter for the supplements will be prepared by Mr. Jos. Sachs, and will include diagrams of every kind of electrical connection met with in practice. The sheets will all be uniform in size and paged consecutively. A convenient portfolio for their better preservation may be obtained from the publishers.

◆

Electric Power.

The article printed elsewhere in this issue on the electrical plant of the American Lithographic Company, describes one of the most notable electric power factory equipments yet made, both with respect to extent and the thorough manner in which all of the details have been worked out. In this latter connection the plant is in striking contrast to many others, even of recent date, and, as an example of thorough electrical engineering, is decidedly creditable to Messrs. Ford & Bacon, under whose specifications the work was performed. It will be noted that the equipment is fireproof throughout. Iron-armored conduits are used entirely, and the construction is everywhere not only permanent, but essentially mechanical, this latter, in fact, being one of the notable features of the plant in in all of its various details.

No less than 141 motors are used throughout the building, and all are direct-connected, either to the larger machines or to the line shafting, in the former case excellent electrical provision being made for press control. Among other interesting points are the switch-board design, the details of the wire runs, of the distributing centers and of the cable runs in the generating room. The lighting by means of enclosed arc lamps has given particular satisfaction. Much of the press work of the establishment is in colors, and the distribution and character of the illumination is such that the pressmen are thereby enabled to mix and match their colors as if working in daylight. As to economy of operation, the data from carefully kept records show this to be extremely satisfactory, an electrical horse power at the switch-board being obtained on 4.45 lbs. of coal per hour, with a low load factor. In the mere item of coal alone, and aside from economy resulting from the enhanced quality and quantity of the output, the new plant has produced a saving of 44 per cent. over the former system of light and power supply. These figures speak eloquently of the advantages of electric equipment which, in all large establishments, will probably soon entirely displace the older, more expensive and less cleanly and convenient methods of power distribution.

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Polyphased Armature Windings.

In another column will be found an interesting article by Mr. J. P. Stone on the windings of polyphase armatures, which should go far toward dispelling the idea held by many that such windings are especially intricate. As will be seen, the Y-winding consists merely of two ordinary alternator windings in the case of two-phased machines, or three such windings in the case of three-phased machines. Two-phased windings are entirely disconnected on the armature, an analogy to such a machine therefore being two simple alternating-current machines with their shafts rigidly connected, and corresponding wires displaced with reference to the poles, by half the distance between poles. A similar analogy to a Y-wound three-phased machine would be three simple alternators with their shafts rigidly connected, with corresponding wires displaced a third of the distance between poles, and with three collector rings—one ring of each of the three pairs of rings—connected together.

The delta winding is merely the usual direct-current winding, tapped at four equidistant points for two-phased working, or at three equidistant points for three-phased working. As pointed out by Mr. Stone, the selection of either type of winding for polyphased machines is merely a matter of convenience. Where a neutral wire is to be run from a three-phased machine, the Y-winding must be used, the neutral running from a fourth collector ring being connected to the common point of the three windings. Such a neutral will supply three additional circuits of a lower voltage than that of the main circuits; that is, if the voltage between the neutral wire and the three main wires is 1000, the voltage between the three mains will be 1732. By placing three rings on the commutator of any direct-current machine, the rings being electrically connected to three equidistant bars, the machine will be a three-phased, delta-wound alternator, so far as generating alternating current is concerned.

◆

Alternating-Current Patents.

Three patents were granted on December 21 to Mr. Rudolph M. Hunter, of Philadelphia, which were heralded in the newspaper press as covering fundamentally the principles of alternating-current distribution, and the transformation from high to low tension and *vice versa*. The dispatch in which the information was given adds that should the Supreme Court of the United States uphold these patents, millions of dollars royalty must be paid under them by electrical companies manufacturing alternating-current apparatus. An examination of the patents, however, does not indicate that these comprehensive claims can be borne out. There are three patents, the earliest date of application being a division of an application filed in February, 1883; the drawing of this patent shows a telephonic arrangement, but the claims are apparently broad and intended to cover the transmission of electrical energy in general. The other two patents relate to the step-up and step-down systems with translating devices in parallel, the original application for these patents having been filed in 1887.

Mr. Hunter, whether justly or not, is widely known as a "paper patent inventor," and with no other evidence at hand than that presented by the claims of the patents here referred to, this designation would seem to be not far removed from the truth. There is nothing new in the transformer principle, which was embodied in the apparatus whereby Faraday demonstrated the principles of electro-magnetic induction. Almost a half century ago the principle of stepping up and stepping down voltages was described in a text-book—Hall's "Manual of Magnetism"—which has a number of illustrations showing how, by means of the induction principle, a low voltage may be transformed into a high voltage and *vice versa*. Berliner, in the first telephone patent issued to him, described the principle with reference to the telephone, his application being dated 1877. Rosetti in 1880 patented a similar electrical arrangement; and in 1881 English and French patents on step up and step-down transformers were issued to Deprez. In 1882 Gaulard & Gibbs gave a demonstration at Westminster Aquarium, of their series transformer system, from which time alternating current working may be considered to take its origin; and the Zipernowski-Deri patents on the arrangement of transformers in parallel date from about 1885.

If there is anything at all patentable in the alternating-current system of distribution, it would appear to be on the placing of transformers in parallel. Such a claim might possibly, however, receive no greater weight in court than did the Edison claim for the ordinary parallel incandescent lamp system of distribution. This is not the only series of patents issued to Mr. Hunter with apparently broad claims covering an entire art. It will be remembered that he also claimed to cover with patents many of the fundamental principles of electric traction. This claim, if patents were accepted at face value and not subject to adjudication, would probably have to be pronounced well founded. It is somewhat significant, however, that the company owning these railway patents has not made any use of them in the extensive litigation of the past several years which has resulted so disastrously to fundamental electric-traction patents.

The Past Year.

While the year 1897 has not witnessed any startling innovations in the electrical field, it has nevertheless been marked by solid achievements in almost every branch. The only new development heralded in a manner that brought up recollections of early years, was the Marconi system of wireless telegraphy. As pointed out in these columns, however, this so-called system contains no new elements, being merely an almost obvious practical application of the Branly tube and Hertz resonator. In electric lighting the most notable occurrence has been the definite triumph of the enclosed over the open arc. At the present time the enclosed arc may be said to have entirely driven out the open arc for constant-potential work, and has also recently begun to enter into use for out-door lighting. The past twelve months have also witnessed great encroachments by the alternating current in the field at one time thought by many to be peculiarly that of the continuous current, the recent action of several Edison Illuminating Companies in adopting alternating currents being a reversal of the policy of these former great champions of the direct current and low voltages.

Another notable advance in the central-station field has been the adoption by the larger companies of rational systems of charges, similar to that which Mr. Arthur Wright has advocated so successfully in England. As will be seen from a note in another column giving the latest tariff of the New York Edison Company, benefit is now given to the long hour user, the rate going as low as 3¼ cents per HP-hour where the consumption is large and distributed over many hours per diem. A reference should also be made to the enclosed fuse, which during the past year has been under process of development. As this type of fuse is claimed, and apparently with good reason, to obviate most or all of the serious defects with brought the open fuse into disrepute, the promise for its future is good. The electrical transmission of power has proceeded with steady strides during the year, the most notable plant being that now in process of construction at Massena, N. Y., and the transmission from Niagara to Buffalo One of the most notable features of the Niagara development has been the somewhat unexpected use to which the power there generated has been applied, and which has resulted in making Niagara a great center of electro-chemical manufacture.

The friends of the storage battery can look back upon a year of successful achievement, and congratulate themselves that at last this important auxiliary has had its merits generally recognized, and is now in a stable position with respect to the future. The many applications made for central-station use and on the distributing systems of electric railways during the past year and several preceding ones, have thoroughly demonstrated the claims that had been made as to its advantages for these purposes. The electric cab also promises to furnish another great opening for its application, as there appears to be no doubt as to the success of the experiments with such cabs during the past year in large cities. In machinery the most important event has been the adoption by the leading manufacturers of the inductor type of alternator, which promises before long to displace the older types of alternating-current machines.

The successful trial of the new Sprague multiple-unit system and its adoption for use on Chicago railways, were perhaps the most important occurrences of the year in the electric railway field. The year has also witnessed the passage of heavy railway electric traction from the experimental stage, and the astonishingly good results obtained on several roads will undoubtedly lead to very great extensions. The growing use of the rotary transformer in the distributing systems of electric railways should also be noted. There is little doubt but that this apparatus will before long be considered a necessary feature in every extensive distributing system.

In telephony the two events of most importance were the confirmation by the Supreme Court of the validity of the Berliner patent, and the organization of the independent telephone companies. The adverse decision of the Supreme Court has affected somewhat the spread of the independent telephone movement, and it is to be regretted that no effort has been made to bring the Berliner patent up for retrial—this time on its merits as an invention. In the general commercial field, there was a steady improvement during the year, and while business has not yet gotten back to its old basis, the advance over the several previous years has been quite marked, and the outlook for the future is bright.

CONSTRUCTION OF A THOMSON ASTATIC GALVANOMETER.

BY H. S. WEBB.

While the Thomson astatic galvanometer has been more or less superseded by the D'Arsonval instrument, it is, nevertheless, an excellent instrument for the detection of feeble currents where great sensitiveness is required. It is, therefore, used for null or zero methods, such as measuring resistance by the Wheatstone bridge; Rayleigh's and Bosscha's methods of comparing the electromotive force of primary cells; Thomson's method of comparing the electrostatic capacities of two condensers, etc. It requires, perhaps, more skill and patience on the part of the user, than the D'Arsonval, and cannot, like the latter, be so easily used in the neighborhood of dynamos or wires carrying strong and variable electric currents.

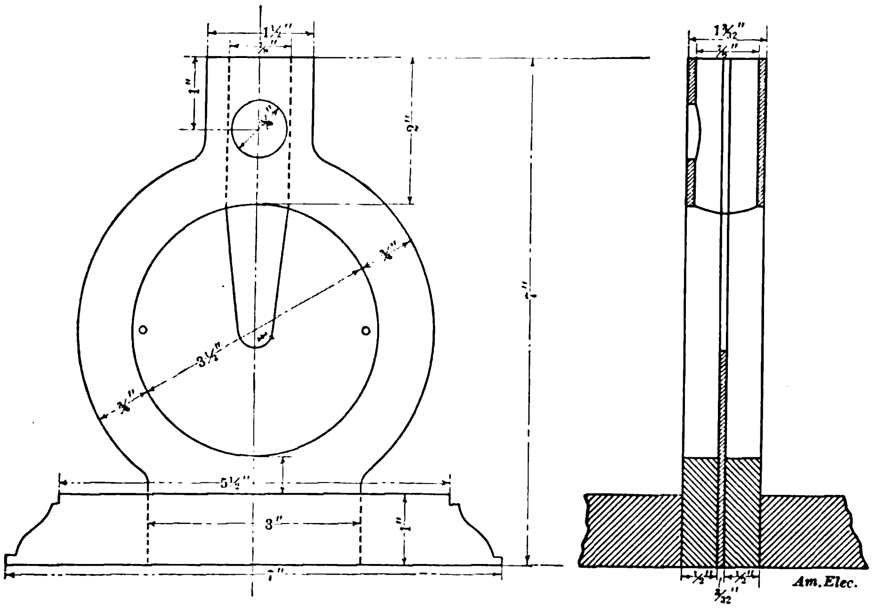


FIG. 1.—FRAME OF GALVANOMETER.

The galvanometer about to be described, has proved a very useful instrument for laboratory work and may be made very sensitive if desired.

The wood-work, as shown in Fig. 1, is made up of four pieces. Into the base is mortised and glued the upright portion, consisting of a thin central sheet or diaphragm, 1/16 in. thick, glued between the two cupcarrying supports. This thin partition holds the two coils apart and is cut away, as indicated in Figs. 1 and 2, to give sufficient room for the suspended system. A hole, 1/8 in. in diameter and 2 ins. deep should be drilled from the top, and another hole in the front, ¼ in. in diameter, as shown in Figs. 1 and 2.

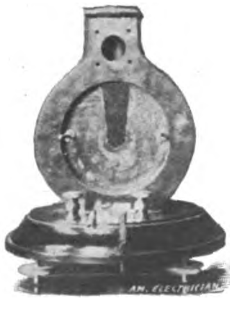


FIG. 2.

This front opening is to be covered with a clear piece of perfectly plane glass, ground round or square, as shown in Fig. 10. To make this glass fit air-tight and yet not break when the screws are tightened, put a washer of rubber, felt or chamois skin under the edge. Fig. 2. is a half-tone of a similar instrument after the two main binding posts, three leveling screws, two spirals of No. 26 silk-covered copper wires, soldered to the under nuts or washers of the binding posts, and two rods for holding the coil cups, have been put in place. Set the binding posts well apart and near the edge of the base to allow plenty of room for subsequently putting in place and removing the front coil cup. These cups should fit snugly into the uprights in order to be as air-tight as possible. Fig. 3. is a scale drawing of the wooden cups for holding the coils.

Well seasoned, hard maple is a very good wood to use and polishes nicely. The inside surfaces of the wood-work should be treated to a coat of shellac. To give the outside a fine polish, proceed as follows: After making the outside surface as smooth as possible with very fine sand-paper, coat it with hard oil. When perfectly dry, rub it down well with powdered pumice stone, using a soft rag and boiled linseed oil thinned with kerosene. Repeat this several times and, the last time or two, use powdered rotten stone in place of the pumice stone.

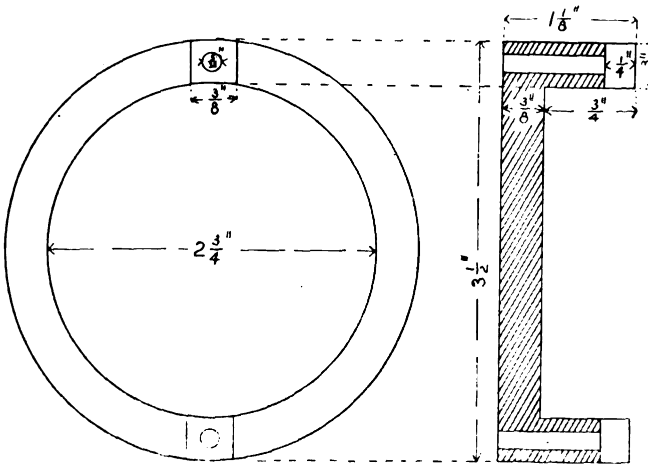


FIG. 3.—COIL CUPS.

Fig. 4 shows one of the leveling screws and Fig. 8 the tapped rod and nuts for holding the cups in place. There are two of these rods, threaded their entire length, eight washers, four small square nuts and four larger ones which show on the outside, (Fig. 11.) Fig. 2 shows how these rods are fastened in place by the small square nuts, one nut on each side of the thin partition.

Fig. 5 shows a form on which the coils are wound. The one from which this drawing was made was constructed of iron because a large number of coils were wound upon it, but, where only two coils, as in the present case, are to be wound, it could be made of some hard wood by slight modification. Before winding the coil, cover that part of the form which is to be filled up with wire, with two or three thicknesses of paraffine paper to facilitate the removal of the coil when finished. The wire coil should fill the form to within ¼ in. of the edge. To make a coil with a resistance of 200 ohms, making a 400-ohm instrument when the two coils are connected in series, will require about 13 oz. of No. 30 B. & S. double-silk-covered copper wire. By connecting the two coils in parallel, instead of in series, the galvanometer will have 100 ohms resistance. In winding these coils it is well to first wind on a single layer of No. 26 wire, to which the No. 30 is soldered, and to terminate the winding with a layer of No. 26. This protects the finer wire and furnishes a more suitable wire for making soldered connections to the binding post washers.

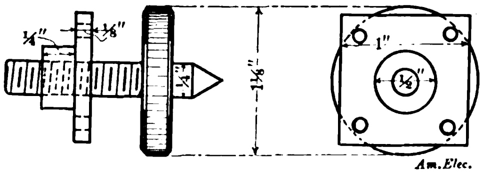


FIG. 4.—LEVELING SCREW,

In soldering wires and connections use resin and not soldering fluid, as the latter, unless completely neutralized and dried off, may later corrode the metal and cause trouble.

The coil, when wound, should be well treated with shellac and allowed to dry before attempting to remove it from the form. To do this, it is necessary to heat the form until the paraffine paper softens enough to allow the removal of the coil from the form. The shellac should hold the coil in shape. The ends of the coil are soldered to washers which are firmly fastened in counter-sunk holes in the inside of the wooden cup by the binding-post screws. After placing the coil in the center of the cup, pour a mixture of melted paraffine and resin into the cup, around the coil, to hold it there. Fig. 6 is a horizontal cross-section of cup and coil complete. Fig. 10 gives an inside and outside view of the same. When the coils are in place, the hollows at the centers of the coils should come exactly opposite each other and just above the bottom of the cut-away portion of the separating wooden partition in the middle of the upright supports, and the surface of both coils should press against this separating partition.

A more sensitive instrument, having the same resistance, can be made by winding the two coils as follows: Over a single layer of No. 26, wind 136 ohms of No. 36, heaping up the wire slightly toward the face of the coil which is to be nearest the needle—that is, on the side of the form where the conical spindle has the smallest diameter. Over this wind 52 ohms of No. 31, and finally, put on 12 ohms of No. 26.

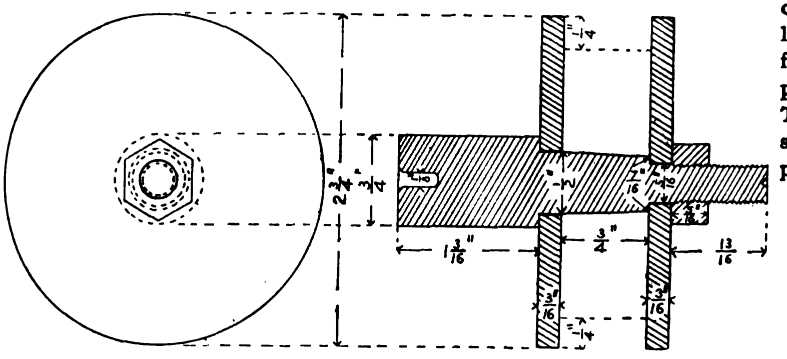


FIG. 5.—FORM FOR WINDING COIL.

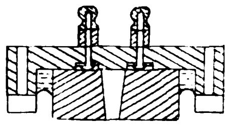


FIG. 6.

The two coils are to be so connected, when in series or parallel, by spiral wires running through and under the wooden base so that the current, flowing through both, will tend to deflect the needle system in one and the same direction; that is, one coil must not oppose the other in its action upon the magnetized needle. The proper ends should be soldered to the under part of the main binding-posts. Two main binding posts, similar to Fig. 14, and four smaller ones, for the coil cups, similar to Fig. 15, will be needed.

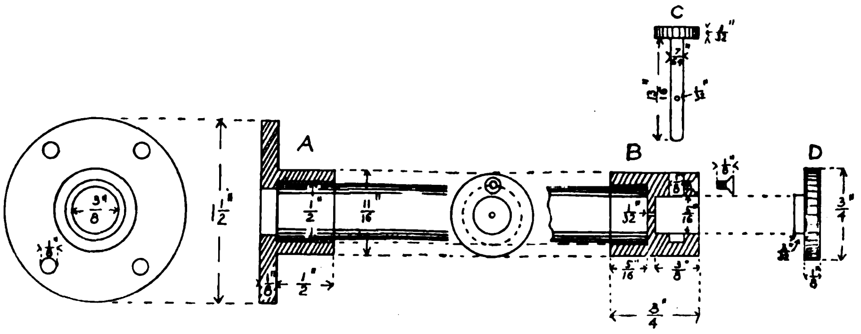


FIG. 7.—DETAILS OF SUSPENSION TUBE.

Fig. 7, shows two brass pieces which are to be connected by a stout piece of glass tubing, 6 ins. in length. The outside diameter of this glass tube should be enough smaller than ½ in. (the diameter of the hole into which it is to go), to allow a piece of chamois skin to be wrapped once around the tube and thus make the two ends fit snugly into the two brass pieces, *A* and *B*. In order that it may not turn, the bottom one is to be firmly secured, with shellac or LePage's glue, on both sides of the chamois skin; but the top piece of the skin is glued on only one side to allow the top brass piece to be revolved around the glass tube to remove torsion from the suspending fibre, whenever necessary, in adjusting the instrument to give zero reading. By using a longer glass tube and, consequently, making the suspending silk fibre longer, the sensitiveness of the galvanometer may be increased.

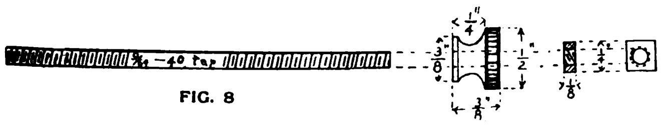


FIG. 8

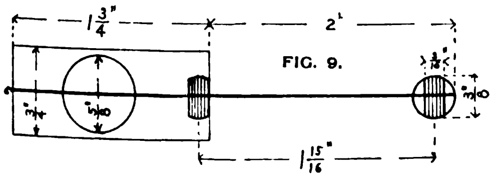


FIG. 9.

FIGS. 8 AND 9.—DETAILS OF SUSPENSION.

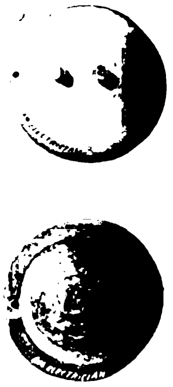
The bottom brass piece, *A* (Fig. 7), is fastened to the top of the wooden framework by four brass screws; but, between the wood and metal, a piece of felt is interposed. This is in the form of a circular disk of 1⅜ ins. external diameter and cut away at the center to allow passage for the suspending fibre. This felt serves two purposes: First, it prevents air currents passing through and disturbing the action of the needle system; secondly, it affords a means of adjusting the suspension tube into perfect alignment with the rest of the instrument by tightening or loosening the proper screws.

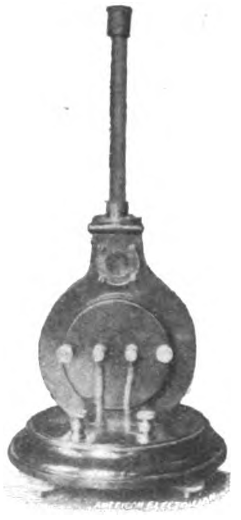
It is, perhaps, needless to remark that no iron in any form, except for the needles, must be used in the construction of this form of galvanometer.

The astatic needle system is shown in Fig. 9. It consists of a very thin, rectangular piece of mica, ¾ ins. × 1¾ ins., to which are fastened, by shellac, a plane glass mirror, from ½ in. to ⅝ in. in diameter, the upper set of steel needles, and a thin glass fibre about 1/50 in. in diameter. The object of the mica vane is to dampen the vibrations and help bring the needle system to rest and, for this purpose, it should be as large as the space, in which it swings, will allow. The space which contains the needle system and the silk suspending fibre should be made as air-tight as possible to prevent external gusts of wind or currents of air from entering and causing the needle system to vibrate and shake. When finished and set up ready for use, the mirror should come opposite the glass-covered hole in the front of the instrument. It is difficult to make a good mirror and is more satisfactory to purchase one from an electrical instrument maker. However, if the reader desires to make one, he will find the necessary directions on page 169, AMERICAN ELECTRICIAN of May, 1897.

The glass fibre, used to connect the lower set of needles to the mica vane on which the upper set of needles is fastened, must be perfectly straight and very light. By a little practice, a good one can be made from a small glass tube by heating it over a fish-tailed gas burner and drawing it out. Make a number of these and select the best one. To the top of this secure, by shellac, a minute hook made of No. 36 or No. 38 bare copper wire, and to the lower end glue a very thin circular piece of mica upon which is glued one set of steel needles. The two pieces of mica must be in the same plane. This needle system should be as light as possible (not over ten grains), to make its moment of inertia small. Other things being equal, the smaller this moment of inertia, the quicker it will come to rest.

The steel needles may be made from steel piano wire about 1/40 to 1/50 in. in diameter, or No. 8 guitar string. The temper should first be drawn and the wire straightened and cut into convenient lengths—about 6 ins. long. These pieces must then be tempered glass hard. This should be carefully done, as the entire piece should be of the same hardness. From this wire cut or break off twelve pieces of the proper length (as indicated in Fig. 9) for the needles and secure them in place with shellac, six above and six below, being careful to have a thin air space, about 1/50 in. between each needle, so that they will not touch each other.





FIGS. 10 AND 11.

The best way to magnetize the needles and obtain an astatic system,—that is one set magnetized equally but oppositely to the other,—is to magnetize the set by an apparatus shown in Fig. 12. *A* and *B* are soft-iron rods, $\frac{7}{16}$ in. in diameter. *C* and *D* are soft-iron pole pieces between which the needles to be magnetized are placed, as shown. *G* and *H* are two coils, each consisting of 350 turns of No. 18 B. & S. copper wire. The coils must be connected in series so that the magnetic flux produced by each will produce poles, as indicated in the figure. The trough is merely a variable liquid resistance containing some liquid, such as salt water or a solution of washing soda, and two metal plates or electrodes, one of which can be moved from one end to the other, so that the current may be varied from 0 to about 5 amps. Any other convenient variable resistance which will do this may, of course, be used.

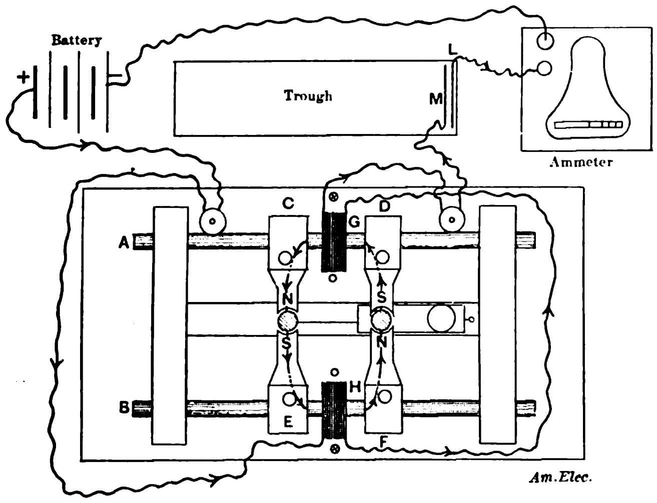


FIG. 12.—METHOD OF MAGNETIZING NEEDLES.

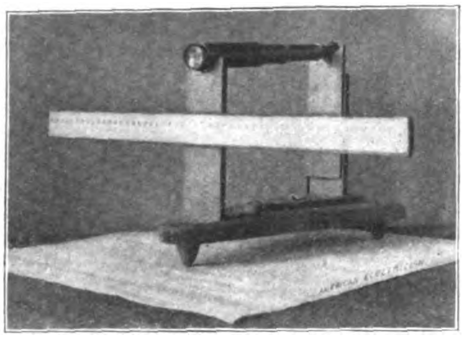
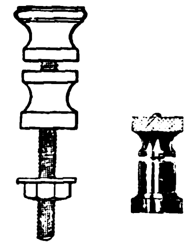


FIG. 13.—TELESCOPE AND SCALE.

After making connections and adjusting the strength of the solution so that the proper current can be obtained, place the needles between the pole pieces, as in Fig. 12, and put on the full current of 5 amps. and then gradually and slowly reduce the current to zero. Repeating this process several times should magnetize the needle sufficiently, and, if the steel was properly hardened, they may never need remagnetizing.



FIGS. 14 AND 15.—BINDING POSTS.

For suspending the needle system, get a single fibre of unspun silk at least 10 ins. long. To remove all initial torsion, hang this up for a day or so, having fastened to its lower end a small weight of non-magnetizable material, such as a brass screw. Pass this silk fibre through the $\frac{1}{32}$ in. hole in *B*, Fig. 7, and secure one end to *C*, by tying it through the $\frac{1}{32}$ in. hole in that piece. One of the coil cups being removed, work the free end of the silk fibre down through the glass tube. Fasten this free end to the small hook on the upper end of the needle system with shellac. When the shellac is dry, wind up the fibre on *C*, until the lower needles hang in the center of the coils. Then level the galvanometer until the lower needles hang midway between the two coils and turn perfectly free. Replace the coil cup, and if properly leveled, the needle system should still vibrate free and smooth. It will depend upon the resultant polarity of the astatic system whether the instrument should be set facing East or West. This can only be determined bytrial.

If a plane mirror is used, a telescope and scale for observing the deflection of the needle system is more convenient than a lamp, scale and lens. A telescope, suitable for this purpose, can be purchased for $1.80 or less and a one-half meter scale on cardboard can be obtained for twenty-five or fifty cents. If a terrestrial telescope is used, it may be greatly improved, for this purpose by removing the set of rectifying lenses, in which case the figures on the scale must be reversed and inverted. Fig. 13 shows a suitable stand, for this purpose, which may be easily made. It is customary to place the telescope and scale just one meter from the mirror. The rear support for the telescope and the board upon which the paper scale is fastened are arranged to slide up and down for adjusting. The scale should be as much below the level of the mirror as the object glass of the telescope is above it.

Quite a number of galvanometers of the above type with the telescope and scale have been in regular use in the electrical laboratory at Lehigh University for the past two or three years. We have also a number of four coil galvanometers of a similar design, whose resistances run up as high as 5000 ohms, but for general use the two coil instruments are sensitive enough. Considerable of the work on these galvanometers was done by students taking the electrical course during their third year.

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Permanent Magnets.

In experiments made by Preece on different kinds of magnet steel, it was found that steel of the best magnetic quality would retain as high as 2540 lines of force per square centimeter; ordinary steel retained from 1100 to 1700 lines. The working density of wrought-iron and soft steel is about 15,000 lines, and of cast-iron, about 9000 lines per square centimeter, which numbers will serve for comparison.

PRINCIPLE OF THE WHEATSTONE BRIDGE.

Owing to several typographical errors in letters of reference, a note on the principle of the Wheatstone bridge which appeared in the December issue in answer to a query, is here reprinted with the necessary corrections.

To better fix ideas, we will take electric-light currents and voltage, as indicated in the diagram below. If no current flows through the galvanometer circuits, *B D*, it follows from Ohm's law, $C=\frac{E}{R}$, that, the current in *A B C* is $110 \div 55 = 2$ amperes; similarly, the current in *A D C* is $110 \div 110 = 1$ ampere. The drop ($E = C R$) from *A* to *B* is therefore $2 \times 45 = 90$ volts, and from *A* to *D* is $1 \times 90 = 90$ volts. Consequently, the drops to *B* and *D* being the same, the potentials at those points will be equal, and no current will flow through the galvanometer, *G*. That is, it will be seen that when $a \times d = c \times x$, the bridge is balanced. This may be expressed,

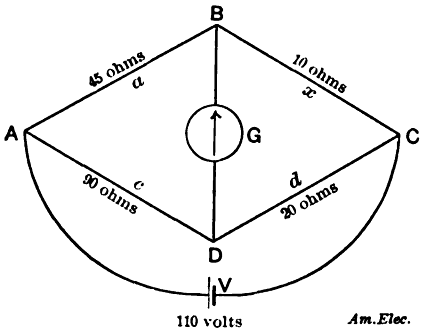

FIG. 1.—DIAGRAM OF WHEATSTONE BRIDGE.

$$x = \frac{d}{c} \times a.$$

In practice, the resistances of the two arms, *c* and *d*, are fixed in a certain ratio for a given measurement (in this case, 20 : 90, but usually as 10 : 100 or a multiple of 10), and the value of *a* is then varied until a balance is obtained.

A plan view of a commercial Wheatstone bridge is shown herewith, having the parts lettered to correspond to the above diagram, *x* being the resistance under measurement. In this case, *c* is the left hand part of the upper row, *d* the right hand part, and the two lower rows correspond to *a*, If *c* were plugged for 1000, and *d* for 10, and if 1425 plugged in *a* brought a balance, then the value or *x* would be 14.25 ohms. As the above type of bridge is actually made, the *withdrawal* of plugs throws in the resistances.

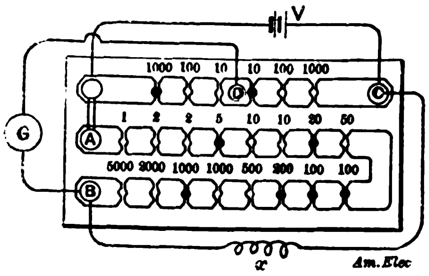

FIG. 2.—WHEATSTONE BRIDGE.

ELECTRIC RAILWAY PRACTICE.

BY EUGENE C. PARHAM.

INSTALLING A TRIAL EQUIPMENT.

Having considered in a previous article, complete in itself, and under the same heading, the precautions to be observed in equipping a truck, and having pursued the course of car wiring from the trolley wheel to the hood switches, we resume our discourse at the point where these important devices become active.

The hood switches are provided as a means of breaking the circuit should accident disable the controller; hence are safety devices. They are also used to "deaden" the motor circuit for working purposes, when pulling down the trolley would put out all lights. These switches are placed in the hood above and a little in front of the motorman's head, and must be so hung that the handle, when "on," can, by the most involuntary motion, be thrown "off." If it is mounted on its board before being hung, unless some thought is used, it will go up backward. The screw holes in the board are laid off, bored, and countersunk; the board is then screwed to two of the hood ribs, the screw heads puttied and the whole painted. The switch is then placed.

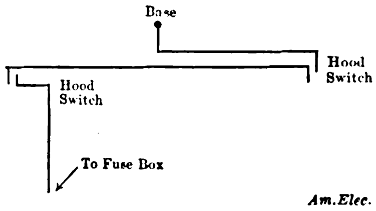

FIG. 1.—SWITCH CONNECTIONS.

We next wire the roof; this consists in running a wire from the base through the switch on one end to the switch on the other, as shown in Fig. 1. The second switch reached will be regarded as on the front end of the car. If the base is not provided with a terminal, the wire must be secured between two washers on one of the base bolts, from around which all paint has been cleaned. Leaving the base, the wire hugs the deck to the end, bends under to avoid the deck sash, runs along the hood to a point just over the switch terminal, and goes through a hole bored to receive it. From the negative terminal a second wire passes up to the hood roof, runs along to the side of the deck and hugs this to the other end, where, as before, it passes through the hood to the rear switch. The wire is held by wood, canvas or leather cleats, and is painted the same color as the car roof. All holes are stopped with putty and a coat of stiff paint. It is a good idea to mark the positive switch terminals, as it saves time when it is desired to connect in instruments. We now pass to the car floor.

On new cars a wire is found sticking out of one side of one of the hood roofs; the other end of this wire sticks through the floor just under the bulkhead. If this wire is missing, or if it is necessary to replace it with a larger one, proceed as follows: On a closed car having swinging end windows, a special moulding between the bulkhead linings conceals the wire, and this moulding must be removed. On an open car the wire runs in a groove in the window post, whose moulding must be removed to show the groove. Passing down the bulkhead, the wire goes through the car floor and connects to one side of the fuse box, which is generally placed on the outside platform stem just behind the car step.

The next device to place is the lightning arrester, of which there are so many types, calling for different conditions, that its position cannot be generally defined. The important condition to fulfill is that the lightning arrester and fuse box connect by a *straight* wire. Some wiring diagrams show the arrester to be tapped on the trolley wire before it enters the fuse box, and others show it tapped on afterwards; neither seems to affect the arrester's efficiency. Fig. 2 shows the latter connection. This completes the wiring up to the point where the controllers are active, and it is well now to place the controllers and resistance to facilitate the laying out of the cables.

The controllers go on the platforms, and are so placed as to be conveniently operated by the left hand, while the right retains a hold on the brake handle. The motor cables pass up to the controller through holes bored in the car floor. In standing the controller up to lay out the position of the cable holes and holes for the bolts or lag-screws which fasten it to the floor, the following must be observed·

The controller must stand out from the dash rail to allow a motorman's gloved hand to clear the vestibule; all controllers must be placed alike, so that a single pattern of dash-rail angle-iron will serve as a model for making any number of them; the cable holes must not be bored through an end sill or platform stem and the cable must clear the coupling bar, sand box, snow-scraper, gong and brake rigging. Lag-screws are preferable to bolts for fastening the controller to the car floor, because in case of an end-on collision, the lag-crews give and save the controller.

Before finally placing the controllers it is well to test them for grounds. On single-shop. This consists in cutting the wires to reach from one controller to the other and in splicing on the taps to receive the motor leads, etc. If the wires are cut 5 ft. longer than the distance from one controller to the other, they will do for any controller now on the market. Fig. 2 shows a cable made for a car 29 ft. over all and 26 ft. between controller centers. The wires were cut 31 ft. long, and 6 ins. were lopped off each end. The wires cut, they are sorted into two bundles to be run in separate hose on opposite sides of the car. The trolley-resistance, and trolley-motor wires run in one hose, the ground and ground-motor wires in the other.

There may be three sizes of wire used in a motor cable; on a 30-HP equipment the trolley and ground wires are generally No. 4 B. & S. rubber-covered cable; the motor wires and the highest numbered resistance wire. No. 6 rubber-covered solid wire, and the remaining wires a No. 7 or 8, according to the service. The wires are to a degree distinguishable by their size. Fig. 2 shows a cable of 13 wires, 9 of them trolley, Nos. 1, 2, 3, 4 resistance and motor No. 1 wires go in No. 1 hose; motor No. 2 wires and the ground in hose No. 2.

The two sets of wires are drawn through their respective hose and tagged. The trolley and ground are tagged, for should they become interchanged on both controllers, the result would be not only to oppose the weaker parts of the controller insulation to trolley potential, but to render the motor cut-outs useless under certain conditions liable to obtain. We next select a No. 6 wire and tag it, say, plus field; the other end is found by pulling the wire and is tagged minus field. Selecting another No. 6 wire, it is tagged plus field and its other end minus field. The idea in making the ends of the same field wire of opposite polarity is to have the motion of the car obey the reverse switch indications on both ends. Either the field or armature wires are marked reversely. but not both; all other

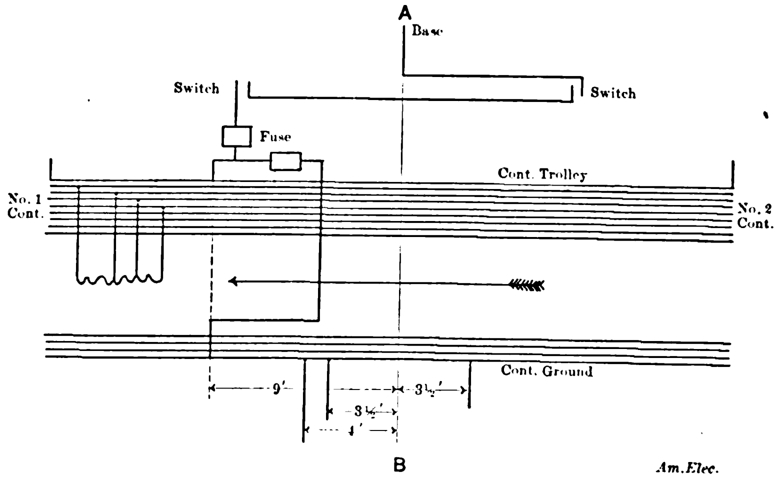

FIG. 2.—MOTOR CABLE.

The next step is to make up the motor cables, if they have not been sent from the end cars the resistance coil is put under the front end to economize on wire, but on double-enders it is immaterial under which end it goes, so long as it is on the same side of the car as the resistance cable. It is a simplifying convention to put the No. 1 end of the coil towards the front of the car.

wires are tagged the same on both ends and as blue print calls for.

The wires all tagged, they are pulled even and so that they protrude 9 ins. beyond the hose on both ends. The hose is straightened and its center and ends plainly marked on the floor, and the center marked on the hose. In all subsequent measurements the centers must coincide. In fixing the points at which the wires are to be tapped, the center line, *A B*, of car, truck and hose is used.

Now, to proceed with the splicing, begin with the trolley wire. The distance from *A B* to the fuse box is 9 ft., so that 9 ft. from the hose center and towards the front end, we cut the hose open and splice onto the trolley wire, a wire of the same size long enough to reach the fuse box. Taking the ground wire next, we see it must have four splices—one for the arrester, 10 ft. front; one for the ground-motor armature lead, 4 ft. back; and a ground wire for each motor frame, 3½ ft. ahead and back of the center line. The rest of the wires have each one splice, to be made opposite the device to which it goes. Splices should never be made alongside of each other, as there is some danger of abrasion. To identify any wire to be spliced, it is only necessary to pull one of its tagged ends and observe it move where the hose is split. As soon as the tap is spliced, it receives a tag similar to that on the wire to which it is spliced.

The splices are made as follows: The cable wire is skinned about 4 ins., and the tap about 10 ins.; both are well cleaned with sand-paper; by means of a pair of connectors and pliers the tap is snugly twisted around the hose wire. If the taps are of stranded wire, the strands are separated, straightened, cleaned, made into two bundles and one bundle twisted to right, the other to the left around the hose wire. When all the joints are made, they are well cleaned with acid and soldered. This is best done by melting solder in two ladles and pouring from one to the other over the joints. If both ladles are heated, the solder does not cool so rapidly. Cooling solder should not be poured, as it forms snags which may pierce the insulation. No molten solder must be allowed to run down into the hose. All splices should be tried for rigidity and inspected for snags and, if necessary, dressed with a file. They may then be given a layer of okonite, two layers of black Manson and a coat of shellac.

The wires are then pulled straight and even and the hose adjusted. A piece of rubber hose, 1 ft. long and split 2 ins. on one end, is slipped on every tap except the trolley tap, so that the two split ends enter the hose and lap around the cable wire. The jaws of the opening in the canvas hose are then drawn together and well taped, after which the hose is given two coats of thick asphaltum and hung up. When dry, it is ready to go under the car. The hose is strapped up by means of leather or canvas straps to the intermediate sill just inside the wheel boxes.

In placing a hose, sight must not be lost of the fact that upon receiving a load the car body lowers three or more inches. Before the hose is tacked up, its center is drawn immediately under the center line of the car, and if a good job has been done, every tap will fall opposite the device to which it connects. The easiest and quickest way to hang the hose is to first tack up one end of all straps along the route selected, poke the two ends of the cable up into the controllers, then begin at the center and work towards the ends; swinging the hose into place, strap by strap, straight and taut and avoiding kinks and corners. If the car is a closed one and the railway people insist on having the cable run under the seats inside the car, the wires and hose must be cut 4 ft. longer. In this case both cables are run on the side that does not contain the stove, and pass to the under side of the car through two holes bored for that purpose under the seat and up as near as possible to the bulkheads. The hose need not be painted except where it runs underneath the car. To place it, it is taken inside the car and its center fastened over the center of the car. The two ends are then passed down through their respective holes.

When wiring a car having radial trucks, care must be had that the hose is placed where the car wheels cannot reach it when turning a curve. Also the motor taps must be left long enough to allow for the displacement of the motors. When a brake is put on the brake rods rise, and all wires must be well out of their way.

The hose swung, the body is lowered and bolted to the truck. The hose is rung out with a magneto and all connections temporarily made; the controller wires are cut off, skinned and put in permanently, except the field wires, which are left long enough to reverse should it be necessary to do so. The trolley is now put on and the lamps should burn if the lamp circuit is all right. If they do not burn, try the test lamps; if they burn, put in the hood switches and try the motors one at a time.

Should both motors run in the same direction and according to the indication of the reverse switch, all connectors can be permanently made. Leads that are a little long can be given a few turns around a screwdriver handle. They are then skinned, dipped in solder, and connected to the cable by means of two-way connectors. As the resistance coils, fuse box, etc., have terminals of their own, they require no terminals. The trolley wire, wherever exposed beneath the car and where it comes up into the controllers, is encased in soft-rubber tubing like that used on the taps. The canvas hose is brought well up into the controllers and its ends are closed with tape and paint.

It was intended that this article should include a consideration of the lighting and heating circuits, as well as a dissertation on lightning arresters, their connections and principles; but this will be deferred to a future article, which will resume where this article leaves off, and take the reader out on the car's trial trip.

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HANDY TOOLS IN A GENERATING STATION.

It is often extremely convenient in power house manipulation to be able to make substantial temporary connections on the switchboard promptly, and such connections may be utilized for many purposes; for instance, an engine may get stuck on a dead point, and a little current turned into the generator would assist wonderfully in turning it over. It is easily possible, where an engine is connected to a pair of generators, to drive one very slowly as a motor, and thus obtain the required speed for turning down the commutator of the other machine.

It may be desirable to take current from the switch-board for many other purposes. Nothing is more convenient in making such connections than a set of jumpers which may be fitted into the switch-jaws and led off in any direction. Sheet-copper of proper thickness should be cut into a shape like that shown in Fig. 1.

The sharp shank, *A*, may be fitted into a handle. The broad flat piece, *B*, should be filed with the edge, *x y*, on a double bevel, as shown in the section, so that it may be easily driven into the switch-jaw. Care must be taken that the thickness of this copper does not exceed that of the switch-blades, for otherwise the jaws would be spread and the good contact of the switch destroyed. The lug, *D*, should be wrapped about the end of the cable, which leads away the current, and should be generously soldered thereto. It is easy to see that a number of such devices will find a use; some should have switch-jaw plugs at both ends, while others would be more convenient if one end only were so provided, the other being adapted to connect in the binding posts of a measuring instrument or a similar device.

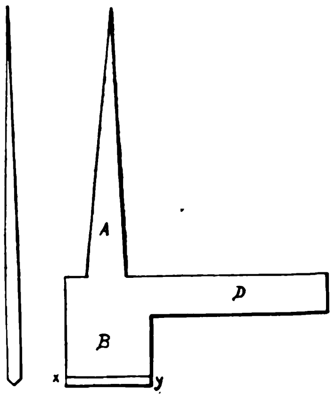

FIG. 1.—JUMPER.

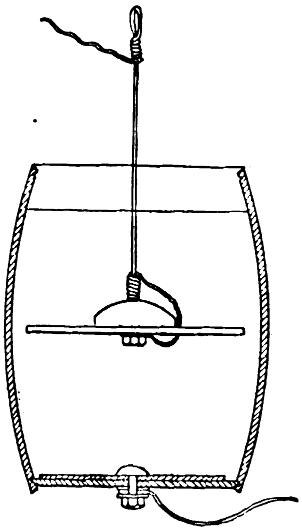

FIG. 2.—WATER RHEOSTAT.

One of the most convenient devices about the power station, is the water rheostat. It is almost as handy as a pair of pliers, and will serve almost any purpose. It is essentially necessary whenever a *little* current is required to be drawn from the mains.

If, for instance, it were desirable to turn over one of the machines as a motor, if the main switches consisted of two single-pole switches, as they should, it would be the easiest matter imaginable to bridge one of the switch-jaws with the water rheostat, by means of a pair of jumper connections described in a previous paragraph. By manipulating the rheostat, the current which the machine received could be varied at pleasure. Indeed, without an equivalent device, the operation would be an impossible one.

For testing arc lamps, shunting circuit breakers, operating railway motors for temporary power, and similar devices, the water rheostat finds a use. Its most convenient form is a barrel, arranged as in Fig. 2. It should be placed out-doors, for the reason that the boiling and bubbling causes offensive fumes. The lower plate is preferably connected to the wire which passes through a water-tight joint in the bottom of barrel.

A good arrangement is to bolt an iron plate, ¼ in. or ⅜ in. thick, to the bottom of the barrel, the bolt being very tightly fitted to the holes in the first place. An additional security against leaks is provided by painting the bottom of the barrel and the interior of the bolt holes with very thick asphaltum. The lower wire should then be secured to one of the bolts by appropriate washers, and setting up the nut tightly compresses the joint together.

A most convenient terminal for letting down into the barrel may be made of an ordinary hitching weight, to the bottom of which a circular ¼-in. plate is tightly screwed. These screws should be at least ⅜ in. in diameter. A large ½-in. cap-screw in the middle is very satisfactory.

The wire connection should loop about the staple, in the middle of the hitching weight, and return on itself a number of times, and then pass through the plate and loop about one of the screws, holding the latter in place. A good strong wire should be selected.

The wire should be the sole support of the weight. If it should break and allow the latter to fall, the circuit would be automatically opened, which would not be the case if the weight were supported by a rope, and the wire merely the flexible connection. The latter connection in the matter mentioned, would cause a serious short circuit.

The lifting of the weight should be accomplished by means of some arc-lamp cord passed over pulleys and wound up on a ratchet reel, such as is common with arc-lamp out-riggers.

This ratchet reel should be within convenient reach of the switch-board attendant, and, of course, the terminals of the rheostat should be conveniently at hand for any connection that may be desired.

The barrel should be mounted on a pair of beams, so as to clear it from the ground, and it should be filled with water, acidulated with 6 oz. of sulphuric acid. The exact amount of acidulation is best determined experimentally. The greater the acidulation the lower the resistance will be, up to a certain point.

A bung should be provided in the bottom of the barrel by which the water may be changed, if it is desirable to change the resistance, and the barrel located conveniently near a tap, so that it can be filled by means of a length of hose.

If these directions are carefully followed out, the result will be of a permanent character, and will be found to be highly satisfactory. Such a rheostat ought to absorb, without very much trouble, 30 or 40 HP.

REPAIRING A "BURNT-OUT" COMMUTATOR.

BY NORMAN H. CROWELL.

If the dynamo-tender understands his business and has suitable instruments at hand, it may be but a matter of a few minutes' time to discover the cause of a "break-down" and set about its repair. If, however, he happens to be a good steam engineer, but a novice at the practice of the electrical art, and tends dynamo by "throwin' her in gear" and trusting to luck, he may as well sit calmly down and wait for reinforcements.

Under the supervision of a competent electrician, a serious break-down is of rare occurrence. There can be little trouble with the machine with a firm foundation, steady power, tight screws, evenly ground brushes, and the constant application of a good big "rag" to the parts where dirt, grease and copper dust collect.

In the case in hand the dynamo had gone on for months grinding out its existence with no attention from the tender. He never knew whether the brushes bobbed, the commutator cut or sparked, or where to oil the journals. This state of things could not continue long without something giving way, and the lights suddenly winked out one night leaving Mr. Engineer "up a stump."

By the aid of a dim and flickery lantern we hastily inspected the dynamo, field magnet, wall attachments, ground wire and even the friction clutch. As far as could be seen everything was tight and in order. Now we must roll up our sleeves and hunt for the "trouble." A small boy eagerly grasps the opportunity to turn the "magneter" handle while we poke around feeling for shocks, and we find a good many.

Everything is found all right until we test the exciter, and here we find a grave condition of things. By placing one wire against a segment of the commutator and the other firmly against the end of the armature shaft, we get a merry tinkle from the bells. By testing the segments one by one we discover that about every third one is in connection with the shaft. We have located the difficulty, and now proceed with the treatment.

We first remove the armature from its chamber and by testing it again we prove our theory to be the right one. Then we make out a little list of articles needed and send the small boy away with it. The list reads as follows: Twenty pieces of heavy mica, 4 × 5 ins.; can of shellac and brush; strip of heavy duck cloth 6 ins. wide; needle and saddler's thread.

While he is in quest of these things, we place the armature in the lathe to facilitate matters and unscrew the burr that holds the cap over the ends of the commutator segments. Next, we remove the "cap," and the cause of the short-circuit is visible to the eye. In several spots the thick mica layers are charred through and when we peel them off we find the copper has a "worm-eaten" appearance.

Take a flat file and cut through the band of wires about the armature head. If the cover is badly worn or torn, file both bands and take the cover off entirely, saving the eyes for use on the new cover. This exposes to view the twenty pairs of wires leading from the armature to the lugs of the segments. Now comes the delicate task of spreading the segments. It is delicate for the reason that they are worn to the thinness of an ordinary pasteboard and require careful handling. However, by pulling gently with the pincers they are lifted from their bed and the charred insulation is scraped and blown away.

At this point, we test the connections between the armature wires and the lugs and find them good. Now carefully inspect the insulation of the base-cap, and if you find it unimpaired, proceed to the laborious task of cutting the mica into strips.

These strips we make ½ in. wide, 4 ins. long, and cut one end off at an angle of 45 degs. Care must be taken to keep the mica from flaking, otherwise you will be greatly hindered in the work to follow. After enough strips are cut, we lay them in a place convenient to our reach and turn our attention to the dismantled commutator. Make sure that no small pieces of insulation adhere to the segments, and then carefully return them to their original position. Slip a heavy rubber band over their base to keep them in their place.

Now we insert the shaft in a vise, with the commutator end uppermost, giving us the most convenient position for handling the ticklish job we now undertake. The next step is to put a strip of the mica between each segment and its fellow, making sure that the pointed end fits the V-shaped recess in the base cap closely. Take a strip and swab it with shellac, then gently pry two segments apart and slip in the strip. The job increases in difficulty as it nears completion.

A small wooden mallet may be used to tap the strips down into place, and this is the place to exercise patience as long as possible.

Now, with the task half done, the mica strips stick out ¼ in. from the normal surface of the commutator, and should project at least an inch beyond the ends of the segments. The ends that thus project are now carefully clipped off close to the segments with a pair of sharp shears, care being taken to make good, clean cuts. When this is done, drop the mica ring behind the strips to hold them from the shaft. Now take an extra thick and fine sheet of mica, and cut out a circular piece with a hole in the center. This is to take the place of the old insulation on the "cap," and must fit accurately, and be thick and solid.

Fit this ring to the cap and put the cap on the shaft in position. Now start on the burr. Unless you have access to a special vice for holding the cap firm, it will be very liable to turn, thereby twisting the segments out of position and perhaps destroying the insulation. This must be avoided, but the burr must be set on so tightly that there will be no probability of its loosening, although the direction of the armature's rotation may tend to unscrew it, which is unfortunately the case with many machines.

With the cap and burr in place, we proceed to remove the superfluous mica that confronts us. This is done best with a very sharp knife point. When the most of it has been cut and pared away with the knife, take the file and finish it.

Now, if you have succeeded in getting

the commutator round or approximately so, you may be assured that your job has been well done, but if it presents an oval shape or a very uneven surface, you will probably have the pleasure of going over the whole process again. If it is oval the brushes will bob and dance until the bulging part wears thin and caves in. If uneven, the chances are that it will not permit lathing, and you may have to loosen the burr and spend an hour adjusting it. The commutator should be so nearly circular that a small amount of light filing will complete it.

Having removed the rubber band, you are ready to put on the drum or canvas coating on the armature head. It is a good idea to have some one who is handy with tools attend to the making of a duplicate of the old cover, which is a simple matter, while you are engaged on the other work. Wrap the cover tightly around the head and sew with the saddler's thread. Put on a liberal coat of shellac. Then cut some long strips of medium thin mica to support the band wires. Next wrap some No. 16 (B. & S.) wire around the edge of the drum over the strips of mica at a strong tension. Make a band about ½ in. wide and solder in several places. Care must be taken that no part of the cover or solder bulges out so that it will touch the chamber when the armature is placed in position.

Now everything is completed, and you are ready to slip the armature back into its chamber, adjust the brushes and start up. It will take a minute for the magnet to pick up, but if you have been thorough in your work you will have the satisfaction of seeing the pointer begin to dance, and when you turn the handle, realize that you have saved your company time as well as expense.

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AMERICAN TELEPHONE PRACTICE.

THE MULTIPLE SWITCH-BOARD.

BY KEMPSTER B. MILLER.

When the number of subscribers in an exchange exceeds 500 or 600, the switch-boards so far considered, become inadequate; for in order to afford room for the number of operators needed to properly handle all the connections, the board must be made of considerable width, and is thus too wide for the operators to reach across them with their cords.

The multiple switch-board, which is designed to enable each operator to make any connection required without the aid of any other operator, and without the use of unduly long cords, is used in most of the large exchanges in this and other countries. The idea underlying the construction of multiple boards is very simple. In practice, however, the greatest complexity is met, but this is due entirely to the great number of repetitions of one comparatively simple circuit.

The boards are divided into sections, each section usually affording working room for three operators. Each line, instead of being provided with a single spring jack or terminal, as on the boards used in small exchanges, is provided with a spring jack on every section of the board, and with a drop or other visual signal on one section only. Each section, therefore contains a spring jack for every line entering the exchange, and also a number, usually 200, of line drops. Suppose an exchange to have 300 subscribers. The multiple board would then probably have 15 sections, each containing 3000 jacks, that is, a jack for each line. Each section would also contain 200 drops belonging to the 200 lines whose calls would always be received on that particular section. An additional jack, called an answering jack, is usually provided for each line on the particular section at which that line's drop is located. These answering jacks are placed in a separate panel at the lower part of the switch-board.

Before considering any particular form of multiple board in particular, it is probably well to describe in a general way the operation of the multiple board. When a subscriber calls the attention of the operator at whose section his drop is located, the operator plugs into the answering jack, of that line with an answering plug, and having switched her telephone into the cord circuit of that plug, ascertains the number of the subscriber desired. She then completes the connection with the subscriber called for by inserting the calling plug into the multiple jack of that subscriber's line, one of which is, of course, on her section.

As each section contains one multiple jack, for every line in the exchange, it is evident that an operator will always be able to complete a connection with any subscriber who may be called for by any of the 200 subscribers whose drops are located at her section. During the least busy portions of the day, one operator at each section usually suffices to handle all of the calls originating at that section. As the number of calls increase, two operators may be placed at each section, and during the busiest part of the day three are usually required.

When three operators are seated at a section, the center one can reach all of the jacks on the section at which she works. The operator at her right cannot well reach the jacks on the extreme left hand portion of that section, but she has within her reach a similar portion of the section at her right into which she may plug when necessary. In a similar manner, the operator at the left cannot well reach the jacks on the extreme right of her own section, but can reach with her left hand the jacks on the extreme right of the section at her left. Thus every operator has a multiple jack for each of the entire number of lines within her reach, the right hand operator controlling the right hand two-thirds of her own section, and the left hand one-third of the section at her right; the center operator controlling her entire section, and the left hand operator controlling the left hand two-thirds of her section, and the right hand one-third of the section at her left.

In order to prevent two or more connections being made to one line at different boards, some sort of a test system is necessary. It is therefore usually provided that when a line is "busy" that is, when it is connected to some other line for conversation—that an operator at some other board than the one at which the connection is made, in trying to connect another party to that line, will in some simple way be notified of the fact that that line is already busy. This is known as the "busy test" and on its efficiency to a great extent depends the operativeness of the multiple board.

In the accompanying figure is shown diagrammatically three lines passing through three separate sections in a multiple board. One side of each line—for instance, of line 1—passes in multiple to all the contact rings, *b*, of a jack on such section. It then passes to one terminal of the line drop, d^3. The other side of the line passes to the spring, *a*, in the jack belonging to that line at section 1. This spring rests against an anvil, *c*, to which a wire is connected which runs to spring, *a*, of the jack belonging to that line on the second section. The anvil from this jack is connected to the line spring, *a*, of the jack on the third board, and so on the connection of the line is continued through a jack on every section and finally to the other terminal of the drop, d^3. Lines 2 and 3 pass successively through the sections in a similar manner.

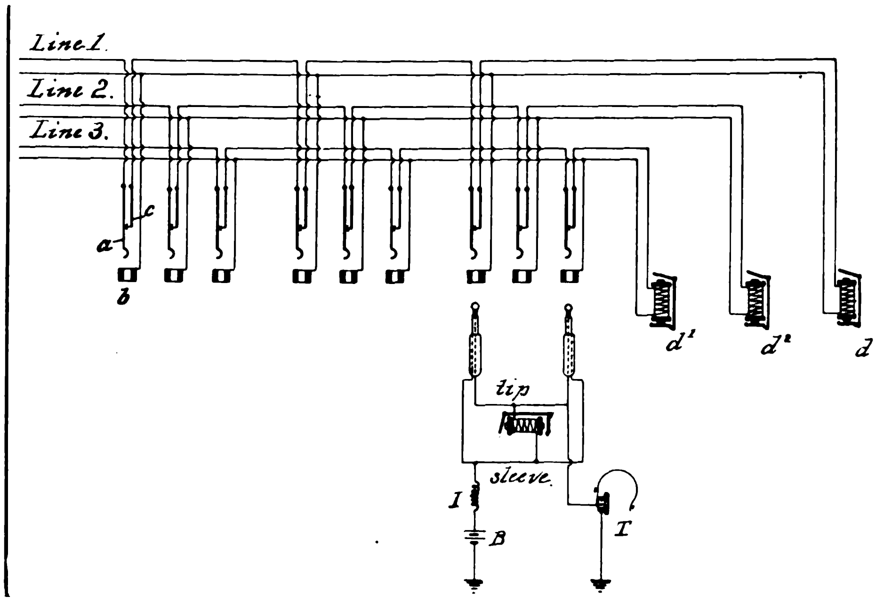

DIAGRAM OF MULTIPLE SWITCH-BOARD.

When a subscriber operates his generator, the current passes over the line wire through all of the contacts, *a* and *c*, in series, through the drop coil, and back over the other side of the line. When an operator inserts a plug into a jack, the spring, *a*, is lifted from contact to the anvil, *c*, by the tip of the plug. The sleeve of the plug makes connection with the test spring, *b*, and thus the tip and sleeve strands of the plug are connected, respectively, into the metallic circuit of the line, while the circuit through the drop is cut at the anvil, *c*.

The operator's telephone, *T*, may be then bridged across the cord circuit in order to enable the operator to converse with the subscriber who has called. Means for connecting the operator's telephone in the circuit in this manner are not shown in this figure, but will be discussed in a later article. This telephone is shown grounded from the tip side of the cord circuit in order to better illustrate the principles of testing in this system.

The sleeve strand of each cord circuit is grounded through a battery, *B*, and in order that this ground may not produce serious effects in unbalancing or crossing the circuit of two connected lines, an impedance or reactance coil, *I*, is placed in this circuit. Whenever any plug is inserted into a jack, one side of the test battery, *B*, is thrown on to all of the test rings, *b*, of the line to which that jack belongs. If now, an operator at another board desires to make a connection with that line, she touches the tip of her answering plug to the test ring, *b*, of that line. This will connect the test ring, *b*, to ground, through her telephone, *T*, and a click will be heard, due to the passage of the current from battery, *B*. The operator will therefore know that that line is busy, and will refrain from making the connection.

In the figure the three lines have their drops located at section 3. It must be remembered that other lines would pass through jacks on the various sections in a similar manner, but would have their drops located on sections 1 or 2. The operator at any section will, of course, answer calls on lines terminating or having drops on her section only, but she may be required to connect one of these lines to any other line in the exchange by means of the multiple jack. The calling and listening in may be performed by substantially the same form of keys as those described in connection with smaller boards.

The arrangement of circuits here shown is that used in what is termed the series-multiple board, the name series being derived, of course, from the manner in which the line passes through the contact springs and anvils of the multiple jacks. This system, although widely used, is subject to grave defects, and is being rapidly replaced by another form of multiple board known as the "bridging" or "branch terminal multiple." In the series-multiple an open circuit may be caused in any one of the jacks by a particle of dust or other foreign insulating matter becoming lodged between the line spring and its anvil, or by virtue of one of the springs becoming weak and failing to bear upon its anvil. The liability to open circuits, therefore, is very great, especially in large exchanges.

Another serious objection to the series board is that when a plug is inserted into a jack, one side of the line is cut off at the anvil of that jack, but the test side is not cut off, and is continuous through the drop of that line and back to the anvil of the jack which is plugged. This, in a large exchange, means that to one side of the line is attached an open branch, perhaps several hundred feet long and containing the drop coil. This destroys to a certain extent the balance of the line, and is liable to produce cross talk.

A MAGIC CLOCK—I.

BY NEVIL MONROE HOPKINS.

Numerous mechanical devices for secretly moving the hands of timepieces have been worked out, producing more or less magical effects. Timepieces as well as magic, date back to the early stages of civilization, and their combination is therefore not untimely. The magic clock herein described may be sealed up under a glass shade and made to run for years without breaking the seal, which adds greatly to the mystery, and forms a most suitable clock for a magician's table, or even his library mantle.

Glass shades usually come with wooden bases provided with little ball feet, and it will be readily seen that the electrical contact system can be duplicated in the glass shade and stand, in the manner it is used in connection with the clock base and table.

Fig. 1 represents the general appearance of the simplest design of clock which may be built on this plan, having only one hand to point out the time. A clock can, of course, be put together having two hands, but it will require another set of wheels in the base with additional gearing and a second moving glass plate.

If the clock is constructed with only one hand it had better be large and of an ornamental design cut from bone or ivory, as some will suggest that the working of the hand is dependent on magnetism if the hand is iron or steel.

Fig. 2 represents a section of the clock from behind. All the mechanism is shown here with the exception of the electromagnet and ratchets which move and control the ratchet wheel, *a*, which turns in a horizontal plane. This ratchet drives a set of bevel gears, which in turn, through the medium of a little cog-wheel at the back, drives the large wheels, *b*, *b*.

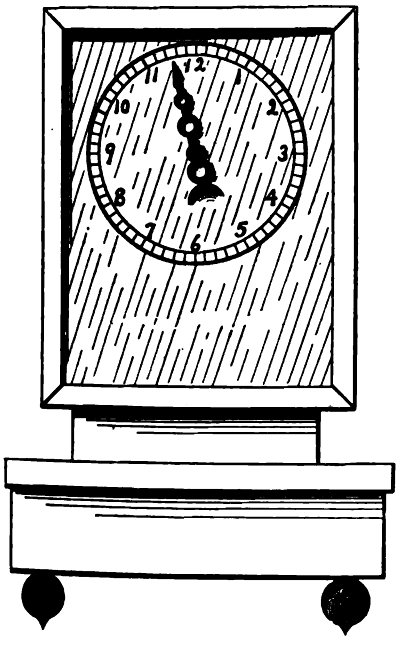

FIG. 1.—ELEVATION OF CLOCK.

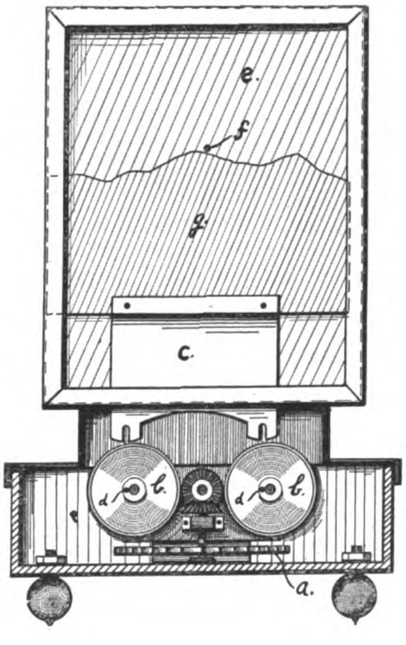

FIG. 2.—FRONT VERTICAL SECTION.

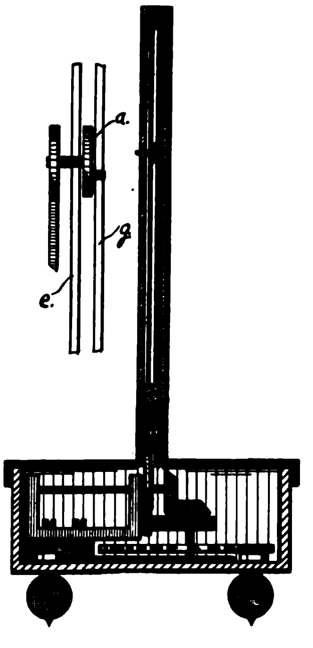

FIG. 3.—SIDE VERTICAL SECTION.

This mechanism will be made clearer by referring to Fig. 3. The brass plate, *c*, in Fig. 2 has the slotted projections cut to engage two small eccentric pins or cranks, *d*, *d*. These slots are filed up until the top of the plate, *c*, is hidden by the frame of the clock when the little pins are at their highest point. The stroke, or throw of the little pins must, of course, be small, in all cases, a trifle less than the thickness or width of the frame.

The frame holds two pieces of thin clear glass, one stationary and the other movable. The stationary plate is represented by *e*, and fits tightly into the frame. The little hole, *f*, which is drilled through the stationary plate, serves to mount the little spindle and hub which carry the hand. The second plate, *g*, is a little smaller than the frame; that is, it is cut free to move back and forth, as well as up and down, through a distance fully equal to the throw or stroke of the little eccentric pins, *d*, *d*. The movable plate is shown at *g*, partially cut away for the sake of clearness. This is represented in the illustration at its extreme left position.

This movable plate also has a little hole drilled through (the plate being cut away here, the hole is not shown) at such a point that it will describe a tiny circle about the hole in the stationary plate. It will be readily seen that the circumference of the little circle which this hole describes will be equal to the little circles described by the little eccentric pins when the wheels are revolved.

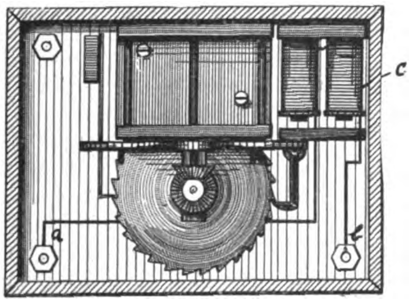

FIG. 4.—PLAN OF BASE.

Fig. 3 shows a side section of the clock mechanism, with a diagram of the glass plates and hub at the left. The working of the plates and hub will be made clear by reference to this sketch, where *a* is the hub carrying the hand on a little spindle, with a little crank pin at the back, with *e* the stationary plate, and *g* the movable plate, turning the little crank pin on the hub, as it is moved by the little crank pins of equal stroke in the base.

Fig. 4 shows a plan of the mechanism with an electromagnet and ratchets in position. The little nuts, *a* and *b*, in this figure, are the terminals of the winding on the electro-magnet, *c*.

Fig. 5 illustrates the clock being driven by battery power to a swinging pendulum in combination with a little mercury cup which completes the circuit through mercury at every beat. This arrangement is only intended for exhibiting the clock before an audience, as the hand is made to travel fast enough to be noticed. The hand should be attached so it may be taken off at any time and passed around. Of course, the circuit can be closed through a telegraph key and the clock run by hand. If the clock is intended to keep time on a library mantle, the connection with a regulating timepiece will have to be different. Here the number of teeth on the ratchet wheel in the base will have to be taken into account as well as the reduction in gearing between the ratchet wheel and the little wheels which carry the crank pins. By making electrical connections with projections on the escapement wheel of a large clock, the hand on the magic clock can be made to follow the hour hand of the regulator clock, if the problem of teeth and gearing is correctly worked out.

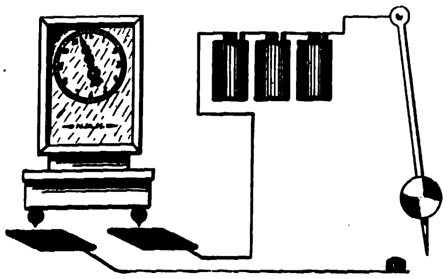

FIG. 5.—DIAGRAM OF CONNECTIONS.

Of course, the magic clock can be placed a long distance from the regulator if good battery power is at hand. For a real timepiece a large battery of bluestone cells, or telegraph battery will give the best service. The base plates which make contact with the sharp points of the bolts can be covered with almost any table or mantle covering, as the clock is heavy enough to pass the points, if sharp, through very heavy material.

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ROTARY VALVES.

There is at present considerable difference of opinion among makers of engines regarding the manner of making rotary valves, as may be gathered from the statements made in the preceding article. Still another point of difference is whether to use the "original" Corliss valve, as shown by Fig. 1, or to use the "through" stem, in preference to the "T head" stem illustrated in the engraving. The cross section shows very plainly the manner of putting in the springs, where such appliances are used. The engraving also shows the manner in which the valve is attached to the stem, a top and a bottom view of the latter being shown.

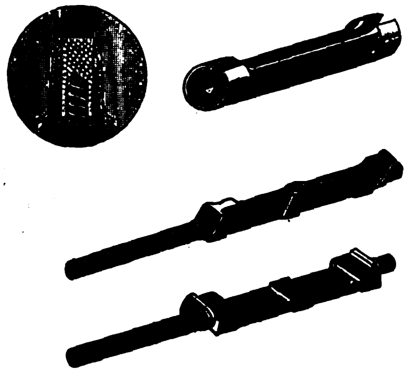

FIG. 1.—"ORIGINAL" CORLISS VALVES.

A number of engines use valves of the rotary type for exhaust purposes, while the admission is controlled by ordinary slide valves, or by those of the piston variety. Fig. 2 presents a form used in connection with double-faced slide steam valves. In this engraving, the small arrows indicate the direction of flow of steam, while the large arrows show the direction in which the valve is moving. Really, this form consists of two double-ported valves with arc-shaped faces fitting the bore of the valve chest, and placed loosely on a central stem which drives them both, and allows each to be held tight to the seat by steam pressure.

Steam is admitted from the valve chest over the edge of valve, and also through the port in the valve, thus giving a very rapid and wide opening. At the same time, the exhaust from the other end of the cylinder has a very direct, though curved passage from port to the condenser. This valve is driven by a rocker arm, and if used as an intermediate, it can be actuated by a wheel governor, although not so connected in the engraving here shown.

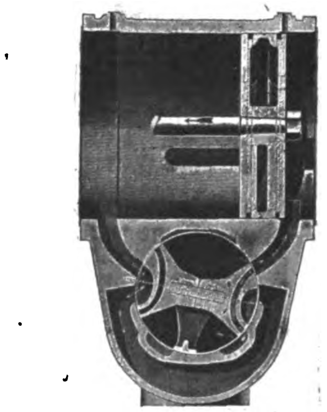

FIG. 2.—ROTARY EXHAUST VALVES.

In the vertical compound engine illustrated by Fig. 3, the valves are actuated by a rocker arm, and controlled by a connection between the arm and a wheel governor. It will be noted that the steam valves are hollow and placed on the ends of the cylinders, thus securing extra short ports and consequently small clearance space. The action of the wheel governor is transmitted by means of a compound connection something after the style of that used on the Porter-Allen engine. This, and some other typical valve connections, will be described in a future article.

Another rigging with slide steam, and rotary exhaust valves, is shown in Fig. 4. Here, the exhaust valves are actuated by a separate eccentric which is connected to both valves by means of a single rod. Or, I might say that the valves are each connected to a short rocker arm, the arms being connected together with a parallel rod. The rod from the eccentric is connected to the first of the short rocker arms, which thus works both valves with a single motion, one being open while the other is closed. The steam valves are actuated from a wheel-governor eccentric, which works the regulation by changing the stroke of the valve in a manner described in the September issue, under the title of "Wheel Governors."

A queer arrangement, which, while it may not be called a distinct form of valve, still possesses very distinctive and interesting features, is shown in Fig. 5. Any form of regular Corliss valves may be used, and the structure itself consists of an auxiliary steam-chest which may be bolted to the cylinder of a plain slide-valve engine. It is intended to give the distribution secured by a regular Corliss valve, and it will do so with the ad-

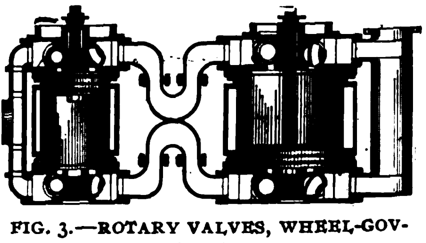

FIG. 3.—ROTARY VALVES, WHEEL-GOVERNED.

dition of a considerable percentage of clearance, and the use of long steam passages. How these losses would figure up against the saving derived from automatic regulation, I am not able to state, but it seems to me that after the time of making and fitting the new steam-chest, and the putting of it on steam-tight, has been summed up, it would be found to amount to fully as much as the cost of a new Corliss cylinder for the engine. If this is the case, or if the cost comes anywhere near the cost of a new cylinder, the saving in steam by the use of the smaller clearance of the new and regular Corliss cylinder, would more than pay the interest on the extra cost of the "full-blooded" cylinder, whatever that might amount to.

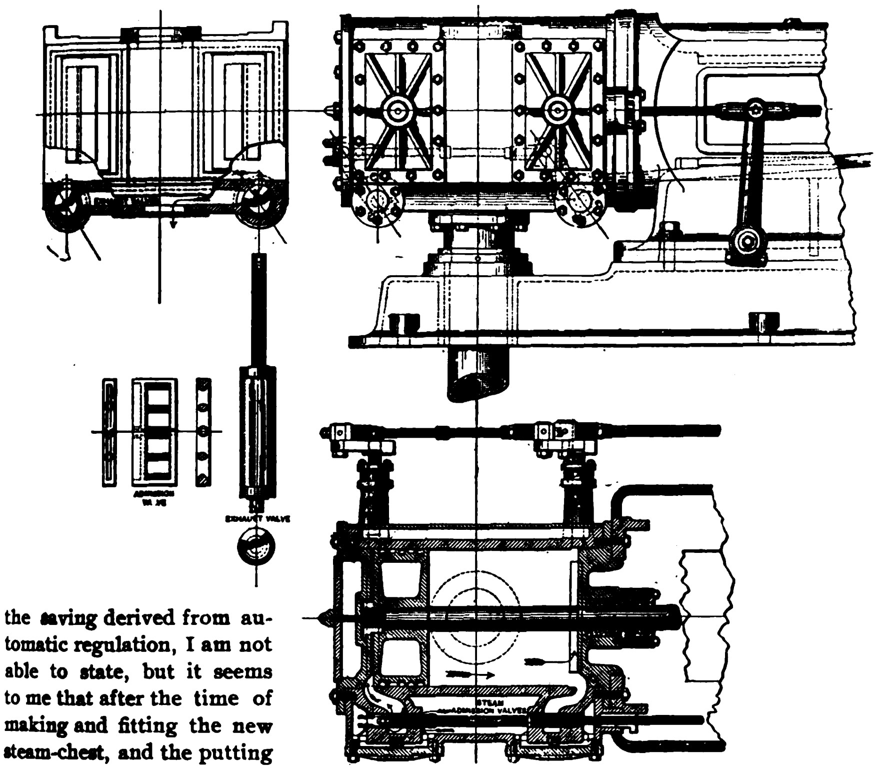

FIG. 4.—DIRECT-CONNECTED ROTARY VALVES.

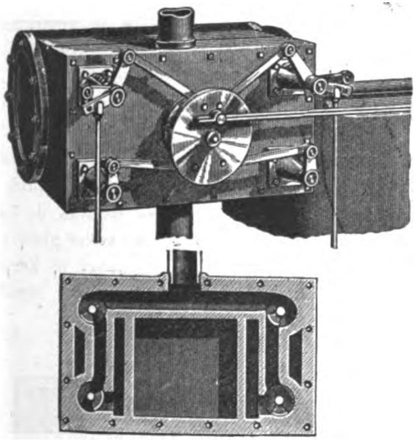

FIG. 5.—A CORLISS 'VALVE CHEST."

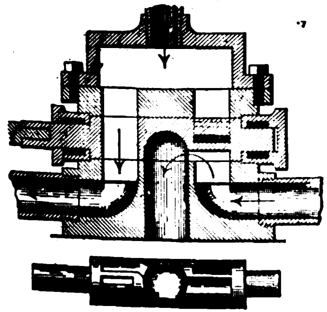

FIG. 6.—ROTARY STEAM-CHEST VALVE.

Another steam-chest valve is shown by Fig. 6. This valve is to take the place of the plain slide form of construction, and may be worked by motion from a wheel governor if desired. The upper engraving is a section through steam-chest and valve. The lower one is a perspective view, looking down on top of the valve, which has steam ports at different angles, one at each end, with an exhaust port between.

From the latter, channels lead in opposite directions, these channels being out of line with each other, but each being in alignment with the steam port on the opposite side, so that when one port is admitting steam the other is exhausting the steam from the other end of the cylinder. By this construction, the area of pressure upon the valve is reduced to that of one of the steam ports, and the valve movement is consequently very easy. It requires but little power to operate the valve, as there is very little friction.

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LESSONS IN PRACTICAL ELECTRICITY

CAPACITY.

In alternating-current working the subject of capacity is of minor importance to that of inductance, but is yet one of much interest and has some practical applications.

The simplest form of a condenser consists of two parallel plates separated by a non-conducting medium, usually spoken of in this connection as a *dielectric*. In the case of condensers used in telegraphy and telephony, the conductor consists of alternate layers of tinfoil and of paper treated with paraffine or other non-conducting substance, as shown in Fig. 1.

As to the effect on the capacity of a condenser of different dielectrics, suppose we have two parallel plates separated merely by air, in which case we will call the capacity unity; then if paraffine wax is placed between the plates the capacity of the condenser will be increased from 2 to 2½ times; with vulcanized rubber about 3 times; with sulphur about 3½ times; with shellac from 3 to 3½ times; with gutta-percha 4 times; with mica 5 times and with different varieties of glass, from 6 to 10 times. That is, with glass as a dielectric, from 6 to 10 times as much electricity will be held for a rise of one volt than if air were used.

The above ratios between the value in this connection of air as a dielectric, and of other dielectric substances, is called *specific inductive capacity*.

Suppose we take two plates of tin, place them close together, but without making contact, and connect one plate to one side of an alternating-current circuit and the other plate to the other side, in the same manner that an incandescent lamp would be connected up. As the voltage changes, the two sides of the condenser become unbalanced; with an increasing voltage a current will therefore flow into the condenser, and with a decreasing voltage a current will flow out. For each change of voltage between the two plates, a definite quantity of electricity will flow in or out; if, for example, there were a uniform rate of change from 20 to 50 volts, a current of uniform value would flow into or out of the circuit in order to supply the difference existing between the charge of the condenser at 50 volts and the charge at 20 volts.

By definition, a condenser which when charged with 1 coulomb of electricity has a difference of potential of 1 volt between its terminals, has a capacity of 1 farad. Since an ampere flowing for one second will deliver 1 coulomb of electricity, we see that to charge a condenser of 1 farad capacity requires only a very small amount of electrical energy.

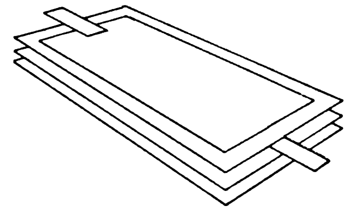

FIG. 1.—TIN-FOIL CONDENSER.

Though this would make it appear that a farad is not a large capacity, it is nevertheless enormously larger than is met with in practice, and consequently for practical work the term *microfarad* is always used, meaning a millionth of a farad. Even a condenser of 1 microfarad capacity forms a large piece of apparatus. For example, if a condenser is to be made of sheets 6 ins. square, and consists of tinfoil between paraffined paper, more than 150 sheets of foil 6 ins. × 6 ins., will be required.*

In order, however, to deduce the law of the condenser as applying to alternating currents, we will assume a condenser of 1 farad capacity. If such a condenser is charged with a coulomb of electricity, or the quantity that would be supplied by a current of an ampere flowing for one second, there would, as stated before, be a difference of potential of 1 volt between its two sides. If the condenser were of 2 farads capacity, then the same amount of electricity would only, we may say, "half charge" it, and consequently the difference of potential would only be ½ volt; if the condenser were ten times as large the potential would be only $\frac{1}{10}$ volt, and so on. We thus see that the voltage at the terminals of a condenser will, for the same charge, be less as the capacity of the condenser is increased, so that if increased K times, the voltage will be only $\frac{1}{K}$th as great; conversely, if the capacity is reduced K times, for the same charge the voltage will be increased K times.

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*The formula for such a condenser is $A = \frac{15458 \times t \times M}{K}$, where A is the area in square feet of one side of the foil; t the thickness of the dielectric in inches; M the capacity in microfarads, and K the specific inductive capacity.

Suppose our farad condenser is on an alternating-current circuit, having a frequency of one period per second. Then the condenser will in each period be, 1°, charged positively; 2°, discharged; 3°, charged negatively; 4°, discharged. That is, in each period there will be two distinct charges and discharges.

If, now, an ampere (coulomb-per-second) of current is flowing as measured by an ammeter in the condenser circuit, one coulomb of current corresponds to two charges and to two discharges, or to one-quarter coulomb per charge or discharge; consequently, the voltage at the terminals will be but one-quarter volt. That is, as the periodicity is increased the voltage is decreased at the rate of four times the number of periods, n, or as $4n$.

While we have used the term alternating current above to fix ideas, the reasoning applies to a uniform flow of current into the condenser. When the flow is alternating, the quantity delivered in a given time is less with respect to the value in the above case, by $\frac{2}{\pi}$, and therefore the voltage at the terminals will be reduced in the same proportion.

We can now apply the above principles to the solution of a problem. Suppose we assume a condenser of one microfarad capacity, a frequency of 100 and a sine wave alternating current of 5 amperes flowing in the condenser circuit (Fig. 2).

Five amperes correspond to $5 \times \frac{2}{\pi} =$ 3.18 coulombs-per-second. But this quantity per second must be divided among 100 periods of four distinct charges or discharges each, or into 400 parts, making $3.18 \div 400 = .00795$ coulomb for each charge. If one coulomb were put in a condenser of one microfarad capacity (one-millionth of a farad) the voltage between its terminals would be one million; and for a charge of .00795 coulomb the voltage would be $1,000,000 \times .00795 = 7950$ volts (which would puncture any ordinary condenser). If one-half ampere flowed, the voltage would be one-tenth less than that corresponding to 5 amperes, or 795 in this case. That is, in order in this case to obtain a current of one-half ampere in the circuit in question having in it a condenser of one microfarad, 795 volts would have to be applied to its terminals.

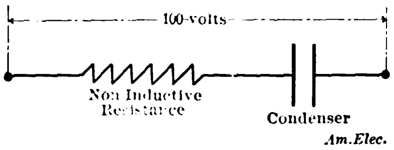


FIG. 2.—CONDENSER AND RESISTANCE IN SERIES.

If we denote the condenser capacity by K, the current by C, the frequency by n, and the E. M. F. by E, necessary at the condenser terminals to produce the flow of current, C, then the above operation may be represented by the simple formula

$$E = \frac{C}{2 \pi n K}.$$

Substituting the above values, $C = .5$, $n = 100$, and $K = .000001$, we have

$$E = \frac{.5}{2 \times 3.1416 \times 100 \times .000001} = 795.$$

The curves and bipolar diagram relating to capacity E. M. F. have been given in previous lessons, and as all of the considerations with respect to such curves and diagrams developed in the last lesson with reference to inductance, apply equally to capacity, they will not be here repeated.

It was shown that all problems relating to inductance and resistance in series can be solved by reference to a right-angled triangle such as that shown in Fig. 3, in which the vertical, OB, represents the CR or free E. M. F.; the horizontal line, AO, the inductive E. M. F.; the hypotenuse, AB, the impressed E. M. F.; ABO, the angle of lag; and the ratio $BO \div BA$, the power factor.

Similarly, all problems relating to capacities and resistances in series can also be solved by reference to a right-angled triangle, such as that of Fig. 4, where ob represents the free E. M. F.; $a\ o$, the capacity E. M. F.; ab the impressed E. M. F.; abo the angle of lead (capacity throwing the current in *advance* of the impressed E. M. F., and inductance the reverse); and $bo \div ab$, the power factor. It is always well to draw the capacity triangle to the right of the perpendicular if the inductive triangle is drawn to the left, as inductive and capacity E. M. Fs. act opposite to each other, as explained in a previous lesson.

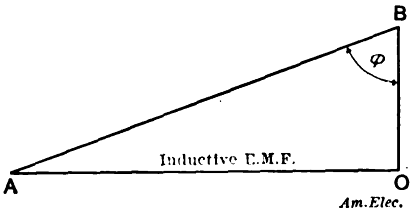


FIG. 3.—INDUCTANCE TRIANGLE.

As an example, we will determine what current will flow in a circuit having in series with each other a non-inductive resistance of 100 ohms and a condenser of two microfarads, the circuit being connected across alternating-current mains of 100 volts and a frequency of 100.

From Ohm's law, $E = CR$, the drop or free E. M. F. for 1 ampere will be $100 \times 1 = 100$ volts.

By the formula just deduced, the E. M. F. at the terminals of the condenser will be

$$\frac{1}{2 \times 3.1416 \times 100 \times .000002} = 795.$$

In Fig. 4 we will have $ob = 100$, and $ao = 795$; solving the triangle, we have

$$(ab)^2 = (100)^2 + (795)^2 = (812)^2.$$

The voltage of the main circuit, however, is only 100, but since the impressed E. M. F. varies directly at the current passing (as will be seen from the formulas) we merely have to reduce the current of 1 ampere that was assumed in the ratio of 100 : 812, which gives .12 ampere. That is, .12 ampere will flow in the circuit of given resistance and capacity in series when connected across 100-volt mains of the given frequency.

The power factor is the ratio of the free to the impressed E. M. F., or $ob \div ab$, or $100 \div 812 = .12$. (It is merely a coincidence that the current and power factor have here indentical values.) This means that while the line voltage is 100 and the current flowing is .12 ampere, the energy in the circuit is not $100 \times .12 = 12$ (volt-amperes), but $.12\ (100 \times .12) = 1.44$ watts.

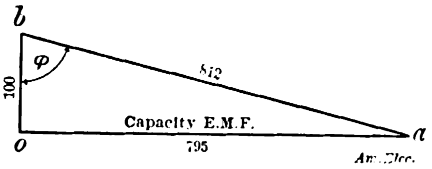


FIG. 4.—CAPACITY TRIANGLE.

This follows for the reason that the condenser absorbs no energy (leaving aside dielectric hysteresis), but gives back on discharge what it receives on charge, in this respect acting like a spring. The only energy used in the circuit in this case is, therefore that dissipated as heat in the resistance, or the C^2R less. As the resistance is 100 ohms and the current is .12 ampere, this loss amounts to $(.12)^2 \times 100 = 1.44$ watts, as found above by means of the power factor.

The above triangular diagrams are not drawn to scale. In practical problems, capacity E. M. F. is usually so small in comparison with the free E. M. F., that the perpendicular and hypotenuse are extremely close. In these lessons exaggerated values of these quantities have been taken, so that the shape of the triangles has been reversed. In working out problems, however, it is always well to do so with reference to a triangle, however greatly it may depart from scale, in order to keep the principles in mind and thereby avoid error.

* * *

Letters on Practical Subjects

Magneto for Firing Blasting Fuses.

To the Editor of American Electrician:

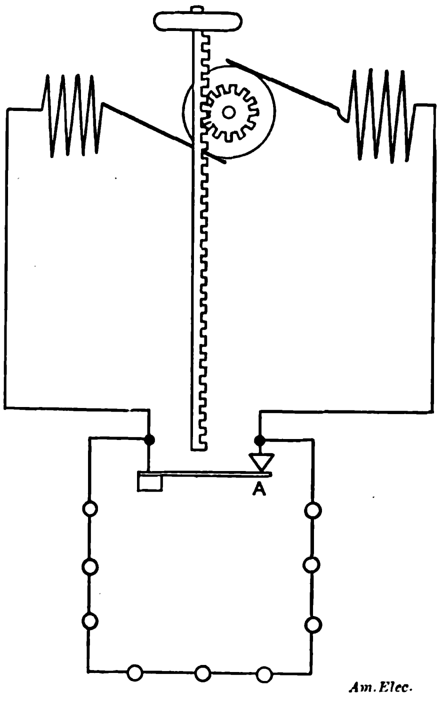
Replying to the inquiry of Mr. James L. Francis in your November issue, as to how a magneto firing machine is connected up and operated, and why his apparatus failed to work, I will say that the more modern blasting machines are small series-wound dynamos with a two-part commutator and connected with firing mechanism, as shown in the accompanying diagram. If the machine is connected as shown in the engraving in his letter, whether it be a magneto or not, his trouble probably lies in the quality of current developed; for, if his magneto were made originally, as he states, to actuate an alphabetical telegraph instrument, it probably does not give out amperage enough to bring to incandescence the fine platinum wire which ignites the powder surrounding it in the exploders.

He will attain better results if he discards his permanent-magnet fields and attaches to the pole pieces instead, heavy soft-iron cores; cast iron will answer.

The fields for a machine capable of igniting 12 to 15 fuses at one discharge should be about 6 ins. long, 5 ins. wide and 1½ ins. in thickness, wound with 6 to 7 layers of No. 14 B. & S. magnet wire, and the armature wound with No. 21 B. & S. wire, preferably silk covered, which will permit of a greater quantity being wound on; the current, of course, is to be commutated.

In operation, until the rack bar, which revolves the armature, strikes the trigger at the end of its stroke the dynamo is short-circuited on itself, and, from the fact of its being a series-wound machine, builds the fields up to full saturation and the whole dynamo into full operative condition by the time the current is switched in the blasting circuit by the bar striking the spring lever, or trigger, at the end of the stroke, and opening the short circuit at the point *A* in the diagram. R. H. STERLING.

Durango, Col.



FUSE-FIRING MAGNET.

Switches for Intercommunicating Telephone Stations.

To the Editor of American Electrician :

The accompanying sketch shows a pair of switches by which independent communication may be held between two telephones, both of them connected with central by the same wire and occupying but one drop on the switch-board. Either can call up the other without calling central, either can call Central without calling the other, but when Central calls both stations ring.

There are many places where such a system is desirable. I have been using it for two years, and for my purpose, between office and residence, I prefer it to having two telephones connected with central by different wires. It is necessary, however, that the two stations be connected by two wires.

To make the switches, a brass circle cut, as shown, is screwed to a hard-wood board about 4 ins. square, and the wires connected to the switch points as indicated.

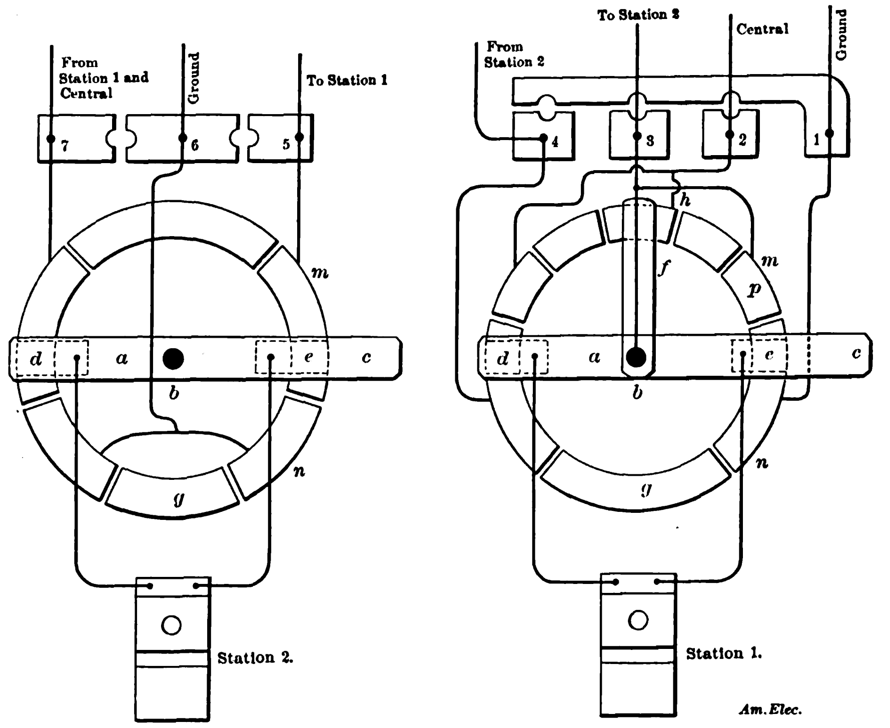


DIAGRAM OF TELEPHONE CONNECTIONS.

The horizontal bar, *a*, extending across the circle, is a wood lever pivoted in the center at *b*, so that the handle at the right at *c*, may be moved up or down. To this bar on the side next the board are secured by binding screws, two brass pieces, *d* and *e*, which slide around on the circle as the handle is moved up or down. These binding posts are connected by wires to the binding posts on the telephone.

To the middle of the bar in station 1 is attached a brass lever, *f*, extending upward at right angles with the bar, to the brass circle. To the pivot *b*, with which this lever is connected, the wire from station 1 to station 2 is connected by way of binding post, 3. The switch point, *p*, is also connected to it.

This brass lever cuts out central when the lever at station 1 is raised. The cut in the circle at *h*, is essential only to prevent either from switching in when the other is communicating with central.

1-2-3-4-5-6-7-(stations 1 and 2) are binding posts on the switch-board to which the line and ground wires are attached, as indicated. 1, station 1, is the ground wire; 2, station 1, is connected to central; 3, station 1 is connected with 7, station 2; 4, station 1, is connected with 5, station 2.

The levers should be left standing horizontally, then both telephones are connected in series with central and grounded at 1. When the handle at either station is lowered to the point *n*, that station is connected with central and the other is cut out. When the handle of either switch is raised to the point *m*, the two stations are in communication and central is cut off.

When the handle of station 1 is raised, the two stations are on metallic circuit. When either handle is raised or lowered it is presumed that the other remains horizontal.

To cut out the telephones and ground the wires, the handles are lowered to the points *g*, and the holes plugged in the lightning arrester.

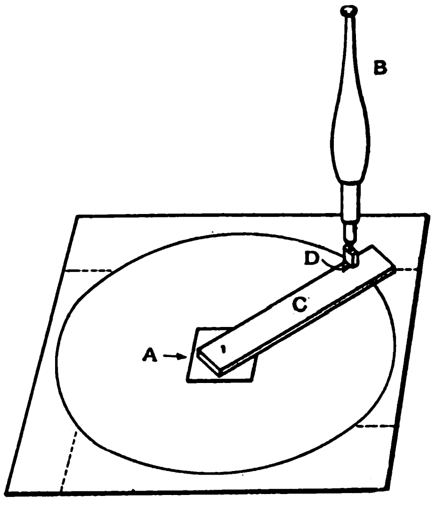
The mechanical construction of the switches may be modified as the maker may desire, so long as the proper connections are preserved. P. F. LANGENOUR.

Statesville, N. C.

Cutting Glass Disks.

To the Editor of American Electrician :

In the belief that some of your readers might be glad to know of a simple way of cutting out glass disks for static machines, I take the liberty of handing you herewith a description of my method.



CUTTING GLASS DISKS.

Referring to the enclosed sketch, a piece of thin wood or heavy card-board, *A*, is glued over the centre of the pane of glass from which the disk is to be cut. The mounting of a glazier's diamond, *B*, fits tightly into a notch, *D*, cut into a flat wooden rod, *C*, near one end; the point of the diamond being allowed to protrude a little. The point of a brad is made to project below the other end, and at a distance from the diamond point equal to the radius of the desired disk. The point of the brad is then pressed slightly into the wood or card-board, and held in this position with one hand, while the other does the cutting with the diamond—the rod acting as a radius arm.

It is important that the cut extend clear through the glass; if it does not do so in any place, it must be tapped locally with a light instrument, on the reverse side, until the cut is continuous. Then the outside pieces can be snapped off by cutting along the dotted lines; this is better than cutting tangents to the circle. After the disk is cut out, the sharp edges can be taken down by means of a course file moistened with turpentine. ANDRE J. PICOLET.

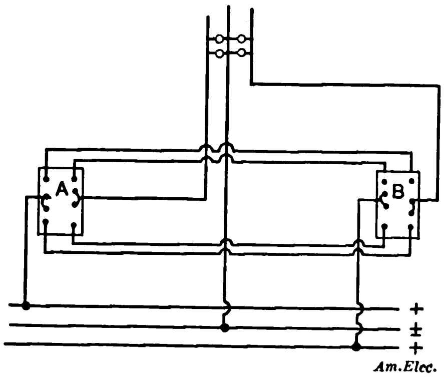
Philadelphia, Pa.

◆

Control of Lamps on Three-wire Circuit.

To the Editor of American Electrician:

In your October number Mr. James L. Francis asks for a sketch, showing how a group of lamps on a three-wire system can be controlled from two or more places. Accompanying this is such a sketch, showing how, with the use of two double-pole, double-throw switches, *A* and *B*, a group of lamps may be turned on or off from two places.



THREE-WIRE DOUBLE-END SWITCH.

This might be used for surface wiring or for temporary wiring where it is desirable to control a group of lights from two different places.

Portsmouth, N. H. A. W. LEE.

◆

Electrical Sport.

To the Editor of American Electrician:

Being an interested reader of the articles on "Electrical Sport" published in your paper during the past few months, but preferring to have my sport with men who are my equals, and having more of a chance to get even than innocent animals and children, I will describe a method I used at a car house with the night-men for victims.

I procured an old tin pail and filled it with tin cans, bolts and stones, and suspended it from the rafters by a fine wire, from which I ran another wire, and connected it to the trolley.

Then I put another wire on the pail in such a manner that it made a contact and remained up in the air when the pail dropped. This wire I ran to a clock some distance away. I then took the alarm key off an alarm clock and covered it with tape.

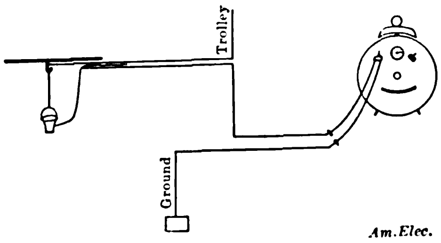


DIAGRAM OF CONNECTIONS.

Around the tape I wound the ends of two No. 18 bare wires so they were insulated from each other and the clock; these were cut about 6 ins. long, and the other ends tacked to the floor or board on which the clock rested.

One of these I ran to the ground and the other to the pail as above stated. I then put the key back on the clock and took off the bell and wound the alarm and set it for 3:30, at which hour night-men are working (?) the hardest.

At the time set the key unwinds, twisting the two bare wires together, which closes the circuit. The fine wire holding the pail fuses and down comes the pail, etc., with enough noise to keep the men away for a week. The accompanying sketch shows the arrangement described.

Attleboro, Mass. JOS. H. SMITH.

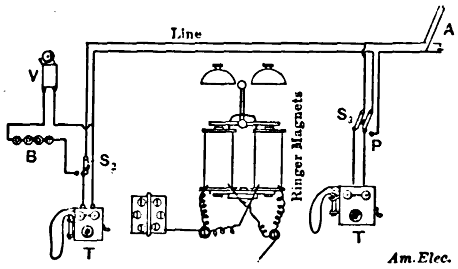
◆

Special Telephone Connections for Burglar Alarm Circuits.

To the Editor of American Electrician:

It often happens that a person living in a small town has his store or business place connected with his residence by burglar alarm wires; should he also wish to add a telephone, the arrangement shown in the accompanying diagram will be found to work very satisfactorily, and it is inexpensive to install.

V is a vibrating bell for the alarm, *B* is the battery, S_2 is a two-point, single-lever switch, *T T* are the telephones, S_3 is a three-point two-lever switch, and *P* is one side of the alarm circuit to the alarm springs, A.



SPECIAL TELEPHONE CONNECTIONS.

If the telephone at the store is left in circuit accidentally, it will ring the vibrating bell as soon as the switch in the house is thrown on. The switch, S_2, at the house end cannot be left in circuit with the telephone, as the telephone is cut-off when the bell is "turned on."

In order not to run down the batteries, it is necessary to use a multiple system of connections in the ringers, as shown in the drawing. The laterals that connect both coils are untwisted and one side of each coil connected to one wire leading through generator to line. This connection has also been found satisfactory on long grounded lines for telephone exchange work.

If the telephone ringer coils are not connected in multiple with each other, as illustrated, they will not always ring the alarm if the telephone at the store should be left on the alarm circuit at night, the resistance of the coils in series being too great. In this case the battery is on a closed circuit all night, and after a few such trials it will be run down.

Bridgeport, Conn. G. E. RUTHER.

◆

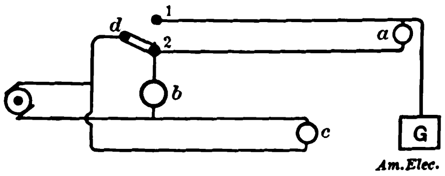
Switch-board Ground Detector.

To the Editor of American Electrician:

A day or two ago I had occasion to place a ground detector on a switch-board where it was not desired to have the device in circuit all of the time. It was also desired to have one of the lamps so arranged as to use it for the illumination of the switch-board cabinet, and to use a third light on the same circuit for the purpose of illuminating the rear of the board.

I arranged the wiring according to the above diagram and obtained good results.

The lamps *a* and *b* were attached to brackets fastened to the upper corners of the switch-board, and the lamp, *c*, was suspended from a cord in the closet at the rear of the board.



GROUND DETECTOR.

One wire from the bus bars was led to a "three-way" switch, *d*, and connected to the double post. A wire was carried from one of the single posts of switch *d* to lamp *a*, and from there to a water pipe and grounded at *G*.

From the other single post of the switch, *d*, a wire was carried to both lamps, *a* and *b*. The wire from the other bus bar was carried to lamps *a* and *c*, and the other side of *c* was connected to wire No. 1.

When switch *d* is set on point 1, lamp *b* burns brilliantly, and when set on point 2 lamps *a* and *b* are put in series and both burn dimly, providing there be no ground on the system. If there be a ground on any part of the system, the lamp on that side of the line goes out and the other lamp burns brilliantly.

All that is necessary to use the system is for the person in charge of the switch-board to turn switch *d*, which is usually kept on point 1, to point 2 momentarily, to ascertain if the system is free from grounds.

By this simple device many break-downs on account of poor insulation may be eliminated. S. E. SANBORN.

Manchester, N. H.

Testing Extraordinary.

To the Editor of American Electrician:

That there are "tricks in all trades but ours," is a foregone conclusion among the members of the various crafts, and the thought and ingenuity expended upon some of the tricks and dodges, would, if expended in true work, increase the salary and standing of the trickster to a notable degree. A case in point: The engineer of a small isolated lighting plant not a thousand miles from New York City was informed that a test of his plant would be run to determine the cost of lighting the building, after which, current from Edison street mains would be turned on, and the cost of thus lighting for a similar period be ascertained.

The engineer knew that if the Edison service cost less than it did to make the current by the plant he was in charge of, that his occupation would be forfeited. Therefore, when the trial run was made, never was boiler, engine or dynamo in better condition than his, and the coal burned was very small.

When the Edison trial was made, he had figured out the cost of everything and knew to a dot what current could be received, and still retain his place. A cunningly concealed water rheostat in the adjoining building was connected by concealed wiring, and the economy of the Edison current received so severe a set-back during the test run that the engineer is sure of his job for some time to come, unless he gets found out.

While not speaking well for the trustworthiness of the engineer, it speaks still worse for the skill of the Edison "expert" who conducted the test for his company. He should have detected the fraud immediately.

S. L. CORSON.

Pittsburgh, Pa.

◆

Operation of T.-H. Arc Dynamos.

To the Editor of American Electrician:

As I have never seen anything in print about caring for Thomson-Houston arc dynamos, I venture to send a few suggestions about these troublesome machines.

In the first place, the commutator, brushes and brush holders should be well cleaned after every run. Adjusting the machine with too short a spark will cause "flashing." The spark can be lengthened by turning the commutator slightly forward on the shaft. This weakens the machine, however, and if it is well loaded, care should be taken not to weaken it so much as to cause the regulator to rest on the stop. The commutator should not be moved more than $\frac{1}{16}$ in. at a time.

Much trouble is sometimes caused by the air-blast being worn out. The hubs should fit snugly in their bearings in the sides of the air-blast. I have seen them with as much as $\frac{1}{16}$ in. play. The General Electric Company will repair them much more cheaply than new ones can be obtained for.

I have obtained the best results by adjusting the air jets so that the blast will strike about ¼ in. in front of the brushes when the regulator is down. Of course, if the machine has to work with a light load, this cannot be done. If the load is very light the armature will get quite hot. This can be remedied by connecting a rheostat between the binding post and connecting-rod post on the right hand leg of the machine. This weakens the field and causes the regulator to run lower. The height at which the regulator runs can be adjusted by turning the rheostat. It should not be more than ½ in. from the top.

When the rheostat is in use, the spark will be longer than usual and may be a little harder on the segments and brushes, but these are cheaper than armatures. The rheostat should have not less than 60 ohms resistance.

Omaha, Neb. CARL C. GILES.

◆

Hydraulic Pumping.

To the Editor of American Electrician:

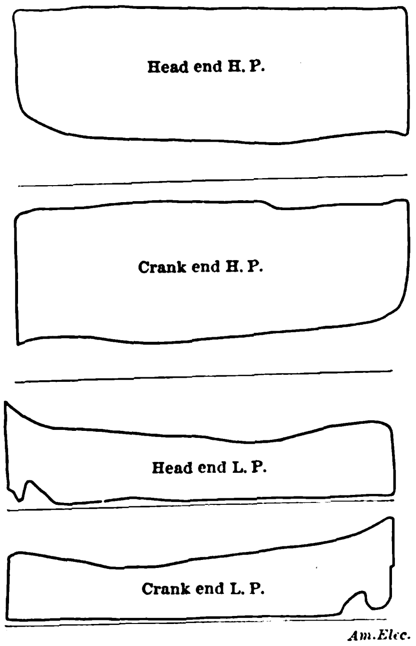
The accompanying cards were taken from an elevator pumping engine, and they furnish a good object lesson as to the relative economy of generating power for hydraulic and for electric elevators. The data are as follows:

High-pressure. Scale,* 60 lbs.; cylinder, 16 ins. × 15 ins.; r. p. m., 28.

Low-pressure. Scale,* 30 lbs., cylinder, 25 ins. × 15 ins.; r. p. m., 28.

With this type of elevator service, the engines generate approximately the same power empty as when loaded—in this respect also differing from electric elevators, and rendering any comparison still more unfavorable. I should be glad to have some reader give from the above cards the I. HP and pounds of water per I. HP. hour.

New York. M. L. TROWBRIDGE.



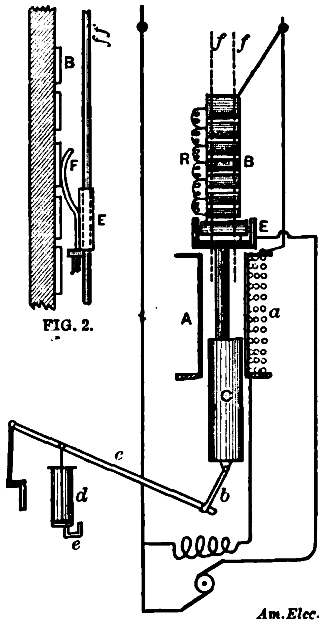
CARDS FROM HYDRAULIC ELEVATOR PUMPING ENGINE.

◆

An Automatic Rheostat.

To the Editor of American Electrician:

The accompanying sketches show the principles of an automatic rheostat, the mechanism of which can be mounted on any of the usual forms of rheostats now in use. The rheostat will automatically start the armature current when the switch is closed, and can be adjusted to move slow or fast at will. The gravity movement employed avoids trouble from the sticking which sometimes affects the working of spring movements.



AUTOMATIC RHEOSTAT.

In Fig. 1, *Aa* represents a magnet in series with a motor field, the winding being on a brass cylinder; *B*, are rheostat contacts or steps; *C*, a plunger that raises the contact shoe, *E*; *R*, resistances; *b* and *c*, lever arms; *d*, a dash pot, and *e*, a check valve. Fig. 2 is a side view of the shoe movement, *E* being the shoe, and *F* a contact spring. *ff* in Figs. 1 and 2 are rods on which the shoe slides, and which also form one pole for the current.

D. F. M. WEAVER.

Wilmington, Del.

◆

That Magneto Firing Machine.

To the Editor of American Electrician:

Noting the reply, under title of "Blasting Fuses," of Mr. Van Deth in December issue, to my letter of inquiry published in November, I desire to advise the writer that experiments had already been made in the direction he suggests, and that I found a single cell of LeClanché battery capable of exploding one of the "electric primers," for which I desired to construct a firing machine. In the experiment, the cell was connected direct to the wires (about 6 ft. long) to which the exploders were attached.

It seemed to require about one second for the current to get in its work when thus attached, but when the magneto provided for that purpose is used, there is no appreciable time between the pushing down of the handle, and feeling of the jar of the explosion, even when six or eight exploders are connected in series.

I am not able now to measure the resistance of one of these exploders, not having one at hand, but it must be very small. Still, Mr. Van Deth does not meet the main question, which is to give a diagram showing how to connect up a magneto for firing one of these exploders. It is done on every large blasting job (the firing) and a magneto is used as stated in the first letter, but when I tried to so connect up a telephone magneto to do the work, I could not make the thing operate.

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* The scales refer to the cards as they are here reproduced.

I have several times fired an exploder at the ends of 50 ft. of wire immersed in fresh, and even in brackish water, with no insulation except that afforded by the cotton winding on ordinary office wire. With a magneto, even this is not necessary, the bare wires immersed in water carrying current enough to fire the shot.

On several occasions, while exploding dynamite at the bottom of driven wells, I have had trouble from lack of insulation where the water was pretty salt, in firing from a 110-volt circuit, but on connecting to a 500-volt railway circuit near by, the charge went off at once. Once, the charge went off, with only one wire attached to the negative wire of the 110-volt circuit, probably from leakage from the 500-volt circuit.

Brooklyn, N. Y. James L. Francis.

ELECTRICAL CATECHISM

178. How can the instantaneous values of the current and E. M. F. be measured when the whole cycle is completed in less than one-sixtieth or one-hundredth of a second?

By means of photography and galvanometers having very light, rapid and sensitive moving parts, the curves may be printed automatically. The more common method is to measure the instantaneous values directly and then plot the curves from these.

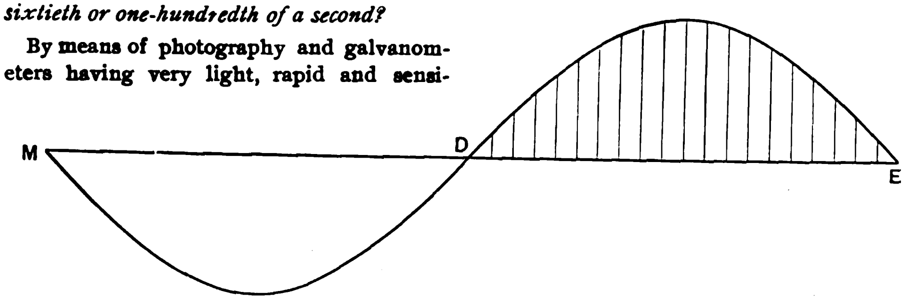


FIG. 2.—SINE CURVE.

179. Explain more fully how the curves can be made to print themselves?

A galvanometer is required having a very light needle swinging in a very strong magnetic field, as suggested by the diamond-shaped needle in Fig. 1. When no current flows through the coils, the needle points in the direction indicated, taking its position directly in the path of the magnetic lines of force between the poles, *N* and *S*. Current through the coils tends to place the needle in the direction of the line *A B*, at right angles to its other position. When the needle is under the influence of both forces at the same time, it will take an intermediate position. Now if the current varies in amount or direction or both, the needle will respond and take a position at every instant corresponding to the relative strength of the current. A beam of light reflected from the needle or from a small mirror attached to it, will take a record upon a photographic plate which is moved at a regular speed in a direction perpendicular to the motion of the light. For this purpose a very sensitive instrument is required and the amateur had better not waste time in trying the experiment. This is outlined simply to give a general idea of how it is done. The more common method is more tedious, but more easily applied.

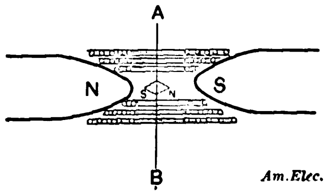


FIG. 1.—MAGNETIC EXPLORING NEEDLE.

180. What is the more common method of determining the instantaneous values of an alternating E. M. F. or current?

There are a number of methods, all being dependent upon the fact that no matter how rapidly the current or E. M. F. passes through a cycle, each cycle is exactly like those preceding and those following. For example, if in the curve in Fig. 2, the distances above and below the line, *M D E*, represent the variation of an alternating current through a single cycle, the current will pass through exactly the same set of values many times each second. In the armature of an alternator there are usually as many coils as there are poles in the field. These are connected in series and are placed symmetrically with reference to the magnet poles, so that the E. M. Fs. in the various coils are all in the same direction and equal at any instant, that is, so that the E. M. F. in each coil is zero at the same time. Now suppose that an insulated metallic disk is mounted upon the armature shaft so that a brush can make continuous contact with it, and having a projection from one side so as to make contact with a wiper or spring once each revolution. It is plain that the wiper will make contact with the projection from the disk at the same point in the revolution of the armature, no matter how rapidly the armature may be rotating. Now suppose that a sensitive voltmeter is connected on one side to one of the mains carrying current from the machine, and on the other side to the brush making continuous contact with the insulated disk, and that the wiper brush is connected to the other main, as suggested in Fig. 3. The wiping brush completes the circuit through the voltmeter once every revolution of the armature and at identically the same point in the revolution. The voltmeter will therefore receive current from the mains for an instant, and the needle or pointer will be deflected—a certain amount depending upon the voltage between the mains at the instant the contact is made. By moving the wiper to other positions, the corresponding voltages may be determined for various positions. By properly calibrating the voltmeter, the actual voltage between the two mains at the instant of contact may be determined for each position, and a curve may be plotted using the successive positions of the wiper as horizontal distances and the corresponding voltages as the vertical distances. There are many details to be looked after for accurate results and many different arrangements of the apparatus have been used, but they are all essentially the same as outlined above.

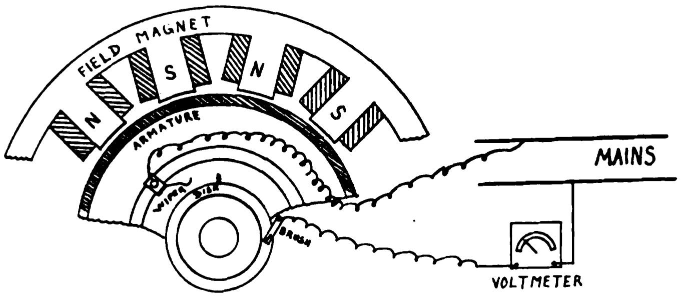


FIG. 3.—DETERMINING INSTANTANEOUS VALUES OF ALTERNATING E. M. F.

181. How can the curve for the alternating current be obtained by such a device?

A small non-inductive resistance may be placed in series with one of the mains so as to carry the current to be measured. By Ohm's law, the fall of potential through the resistance is directly proportional to the current. Pressure wires run from the end of the resistance to the contact device and voltmeter as before, enable us to measure the drop through the resistance at different points and so to calculate the current and to plot a curve for the current in the same way as was done for the voltage between the mains. For measuring the current by this method, it is necessary to have the voltmeter sensitive, since the drop in voltage through the resistance will not be large.

182. How can the relative positions or the difference of phase between the current and voltage be determined?

By having suitable switches, the wires to the contact device may be connected first to one circuit and then to the other, so as to determine the current and then the voltage corresponding to each position before the wiper is moved to a new position. In this way corresponding values for primary current, primary voltage, secondary current and secondary voltage may be determined.

QUERIES AND ANSWERS

What percentage of the total current generated is used in the field of modern dynamos? M. P. C.

From 10 per cent. in small machines to 1 per cent., and even less, in very large ones.

Are alternators ever connected in series? J. H.

No. With alternating currents voltages are raised by the simple means of transformers.

At what point on the sine curve does the E. M. F. change from plus to minus? J. J. G.

When a wire of a generator is midway between two poles, it is at zero potential and on the point of changing to plus or minus.

Would a greater amount of iron in a field core reduce the number of ampere-turns of the shunt winding? M. P. C.

Yes, but as the amount of iron in the field cores of a dynamo is calculated for a definitely fixed point of saturation, the question has no practical bearing.

How can I heat a tailor's goose iron by means of a 100-volt alternating current? E. H. T.

It will be cheaper to buy such an electric iron. The data will have to be determined experimentally. Use resistance wire zigzagged, but not coiled; have a choke coil in circuit while experimenting.

How is the rated candle-power of arc lamps fixed? W. C.

A 2000-CP (nominal) open-arc lamp is one taking 450 watts—usually 10 amperes at 45 volts at lamp terminals. A 1200-CP open-arc lamp is one taking 300 watts—usually 6.8 amperes at 45 volts.

Will hard-wood spools saturated with paraffine be as good for use in an induction coil as rubber or glass? C. J.

No. The value of the spools will depend upon the amount of paraffine absorbed. Hard rubber and glass both offer a much higher resistance to disruptive discharge than paraffine.

I wish to run a dynamo of 15 volts from a windmill. What should the power of mill be? W. E. R.

For how many amperes is the dynamo designed? The question as put can no more be answered than the similar one: What is the horse-power of a water-power whose head is 15 ft.

What is the estimated voltage of a Tesla coil giving a 10-in. spark? H.

It has been claimed that a large Tesla coil will give 200,000 volts. The effect of such coils does not depend upon the mean voltage that is measured with ordinary instruments, but upon the highest voltage attained, which is an unknown quantity.

How can the motor, whose construction is described in the February number, be altered for use on a 52-volt alternating-current, or 550-volt railway circuit? C. N.

The motor will not work on an alternating-current circuit, and it would be impracticable to adapt it for a 550-volt circuit. For windings of battery motors, see page 358, September, 1897, issue.

How are the resistance and the size of wire of a field rheostat determined? M. P. C.

The difference between the voltage at the terminals of the shunt at full load and at no load, divided by the maximum field current, gives the resistance. For carrying capacity of different wires in different forms of rheostats, see March issue, 1897.

Can a storage battery be made of lead and copper in a sulphuric acid solution? S. T.

Yes, but a very poor one. The lead plate will be peroxidized and the copper electrode dissolved on charge; on discharge, the peroxide will be reduced and copper redeposited on the copper electrode. Almost any primary battery is a storage battery in this sense.

1°. Can a water rheostat be made to absorb 12 KW at 115 volts? 2°. What E. M. F. is necessary to produce electrolysis of water? H. N. L.

1°. Yes; see articles on water rheostats in the December issue. 2°. Chemically pure water is not an electrolyte nor a conductor. 1.482 volts are necessary to electrolyze water rendered conductive by the introduction of some impurity.

How may two holes in the insulation between the commutator bars of a G. E. compound alternator be plugged permanently? S.

Fill the holes with sizzling hot melted shellac, dip fibre wedges cut to fit the holes in this, drive the wedges in and pare down flush and polish. It is probable that the only satisfactory cure will be a new mica segment.

1°. Would good soft steel castings do for the motor described in the February number? 2°. In this case, should the dimensions of the field-magnet core be increased? 3°. What are the windings of the motor for a 50-volt circuit? G. L. B.

1°. Yes. 2°. Not if first-class soft steel is used. 3°. Use No. 25 wire on field, winding it twenty nine layers deep, and No. 21 wire on the armature, putting on as many turns as can be gotten in the slots.

What is a "teaser coil"? F. C. M.

In early days a compound coil used on electroplating machine was called the teaser coil. In the monocyclic alternating-current system, the auxiliary armature winding is sometimes called the teaser winding, the line wire leading from it the teaser wire, and the voltage between the latter and either of the main line wires, the teaser voltage.

What should be the size of the core and secondary winding for an induction coil to give a 3-inch spark? R. F. A.

A core one inch in diameter by 10 or 12 ins. long will answer. Use No. 36 wire; if the coil is properly designed after the principles given on pages 18–21, January, 1897, issue, 3 lbs. of wire will be sufficient—otherwise the old rule of 2 lbs. per inch of spark had better be followed.

How may a storage battery by charged from a railway circuit? J. H. S.

It is impracticable to charge a few cells from a 500-volt circuit. For example, to charge 5 cells, 97½ per cent. of energy would be wasted to 2½ per cent. utilized in the cells. If 10 amperes passed through the cells, but 125 watts would be utilized while 4875 watts or more than 6½ HP would be wasted in the resistance necessary to cut the voltage down.

We have four D 62-KW, two M. P. 90-KW and one M. P. 225-KW generators running in parallel on a 550-volt circuit, but in starting up meet with trouble from the 225-KW machine running as a motor. The machine ran all right for a few weeks, but lately the commutator blackens and sparks badly?

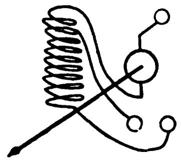
The trouble may lie in the equalizer or in the series coil, but is probably due to a difference in characteristic. See that the contacts are good at the equalizer connections, and that the equalizer conductor is of low resistance. The series coils may be shunted too heavily by the German silver resistance, or one of the coils may be faulty.

I have a T.-H. shunt wound motor, of 250 volts, 45 amperes and 1500 r. p. m., which I wish to use as a dynamo to supply current for arc and incandescent lamps. What changes will be necessary? D. B.

By using two incandescent lamps in series and five open arcs or two enclosed arcs in series, no change will be necessary. To change to 125 volts, rewind the fields with wire of half the present resistance, but using the same number of turns; or rewind with any size of wire, but keep the ampere turns the same. Short-circuit the commutator bars by pairs and reconnect in parallel to the adjacent coils, the armature coils thus thrown out.

What is a calibrating coil on a voltmeter? D.

When a voltmeter has two coils, as in the accompanying sketch, that for low reading is frequently called the calibrating coil. By means of a single cell of storage battery and a water resistance, a 150-voltmeter, for example, can be calibrated by means of such a coil over the entire scale. Instructions are given for calibration by this method on page 232, June, 1897, issue.



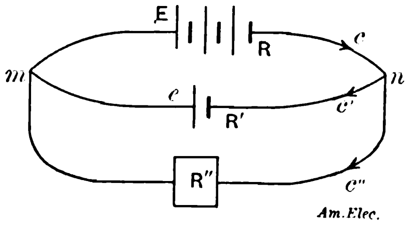
Am. Elec.

I have charge of a 75-KW, 4-pole, 500-volt Westinghouse railway generator, the commutator of which sparks badly at two diametrically opposite bars. If turned down, the sparking and blackening begins a few days after. I have changed the armature, but the new one acted the same. What is the matter? S.

Blackening like that described is ordinarily caused by a loose coil connection at the bars affected. It may be that the machine vibrates, causing the brushes to jump at certain points, thus starting the trouble, which will rapidly grow. To test the field, take a voltmeter and measure the voltage of each of the field coils, both shunt and series; if the voltage of any of these is not practically equal to that of its mate carrying the same current, that coil is probably faulty, which would distort the field and thus possibly cause sparking.

In the accompanying sketch, how are the currents in the three circuits calculated? D.

Let R, R' and R'' be the resistances of the circuits, containing R'', E and e, including the internal resistance of the cells; let V be the difference of potential between m and n, The current in the upper branch will be $C = \frac{E-V}{R}$; $C' = \frac{V-e}{R'}$; and $C'' = \frac{V}{R''}$. But $C = C' + C''$ or $\frac{E-V}{R'} = \frac{V-e}{R'} + \frac{V}{R''}$. Substituting the values of E, e, R, R' and R'', we get the value of V, and from that the values of C, C' and C''.



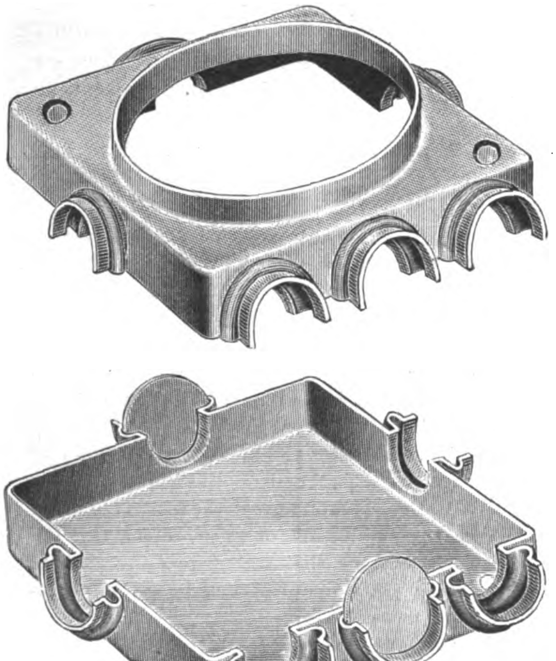
Am. Elec.

New Apparatus and Appliances

A STEEL "SPLIT BOX."

Outlet and switch boxes drawn of steel for use with iron-armored conduit are superior to the cast-iron box generally used for this purpose, both in conception and practical application, and are coming widely into favor. The latest addition to these steel boxes is that shown herewith, known as a "split box." It is very convenient to install, as the cut shows, and is more nearly water-tight than the ordinary split box, because of the unusual length of the lugs encircling the conduit.

An ingenious feature will be noticed on examining the inner edges of these outlet lugs. The openings at that point are smaller than the outside diameter of the conduit, with the result that the conduit cannot be thrust too far into the box. The steel disks shown are removable, but when in position render the openings practically water-tight. The box weighs only 21 ounces, is strong and practically indestructible. The manufacturers lay stress on the desirability of screwing the conduit into the box in order to form a thoroughly water-tight and fireproof combination, and they inform us that in the higher class of work boxes arranged in this manner, with threaded lugs on the sides and bottom for the conduit, are meeting with great favor.

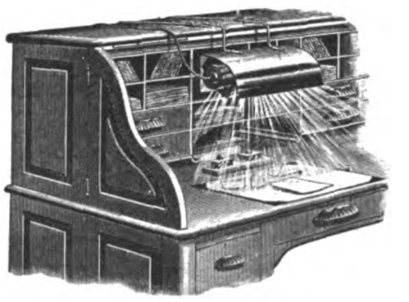


STEEL "SPLIT" BOX.

The Bossert Electric Construction Company, of Utica, N. Y., owns the patent and controls the manufacture of the box illustrated.

ELECTRIC DESK LAMP.

The desk lamp illustrated in the accompanying engraving is applicable to roll-top, flat-top and book-keepers' desks, typewriters' tables, etc. The light is soft and abundant, and so well distributed as to leave no shadows or dark corners on the desk; yet the lamp itself is entirely shaded from the eyes. In appearance it is ornamental and attractive, and in no way interferes with the opening or closing of a roll-top desk. For flat-top desks an upright mounting is used.



DESK LAMP.

All of the parts are of polished brass or nickel. This desk fixture is made by the Wareing Supply Company, 136 Liberty Street, New York.

COMMUTATOR COMPOUND.

The sparking of commutators has long been a source of serious thought and one that has caused the dynamo tender probably more trouble than anything he has had to contend against. It has reduced the working capacity of his motor or dynamo; it has worn out his commutators, wasted power, and in some instances destroyed thousands of dollars worth of machinery. Mr. K. McLennan, for a great many years chief electrician for Swift & Company, gave considerable thought to this question, and after four years of experimental work with machinery and brushes of all kinds, he invented Gale's commutator compound. The material is put up in convenient form, as shown in the accompanying illustration, and is claimed to prevent sparking and cutting of commutators; to save wear and tear of brushes, and to put a high finish to the commutators, without gumming the brushes. The compound is sold by K. McLennan & Company, 1128 Marquette Building, Chicago.

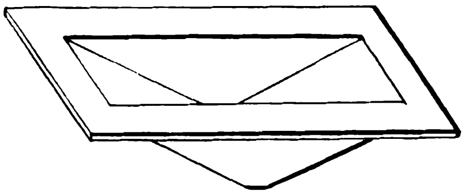
GALE'S
COMMUTATOR COMPOUND

COMMUTATOR COMPOUND.

BRAZING CRUCIBLE.

A new form of brazing has recently been perfected whereby a joint to be brazed is merely immersed in a crucible of molten spelter; the joint not only brazes in a few seconds of time, but comes out of the bath entirely free from scale, a brisk cleansing with a metal brush being about all of the treatment required.

The surfaces to be brazed are painted with a flux, and the adjacent parts with an antiflux. On account of the high degree of heat required, a special crucible for the molten metal is necessary, one of which is shown in outline below. It is 24 ins. × 6 ins. inside, the bottom forming an angle, and 10 ins. deep in the middle. It has a 3-in. flange to support it in a furnace, and can be used in a coke, coal, gas or oil furnace.



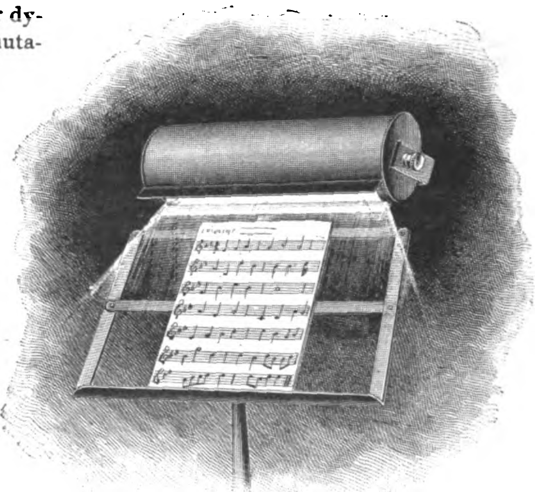
BRAZING CRUCIBLE.

The Joseph Dixon Crucible Company, Jersey City, N. J., manufactures the above described crucible and brazing fluxes.

ORCHESTRA LAMP.

As will be seen from the accompanying illustration, this new type of fixture is cylindrical in shape, the socket being inside the cylinder. The standard fixture is made to take a 16-CP lamp. The cylinder is pivoted on the ends and may be revolved in any direction. The cylinder is composed of two pieces, one of which revolves inside the other so that any desired opening may be obtained, depending on the volume of light required. It is fitted with an adjustable clamp for attaching to music racks.

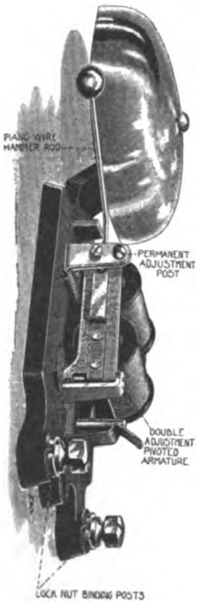
This device, although called an orchestra lamp, is just as valuable for lighting pulpits and pictures. The rector of St. Thomas' Church, New York, it is stated, experimented with several devices for lighting his pulpit, but did not find anything satisfactory until one of these lamps was installed. The fixture, which is known as the Ward Orchestra Lamp, is made by McLeod, Ward & Company, 27 Thames Street, New York.



ORCHESTRA LAMP.

IRON BOX BELL.

The principal feature in the electric bell herewith illustrated is in the mechanical construction, which is such that the various parts once assembled and adjusted, it is impossible to lose the adjustment. Instead of the usual contact post, the present one is made of two pieces of heavy metal placed under different tensions; a screw is provided which puts a tension on the binding contact screw and makes it impossible for either to loosen. Adjustments, however, can be easily and quickly made.



IRON BOX BELL.

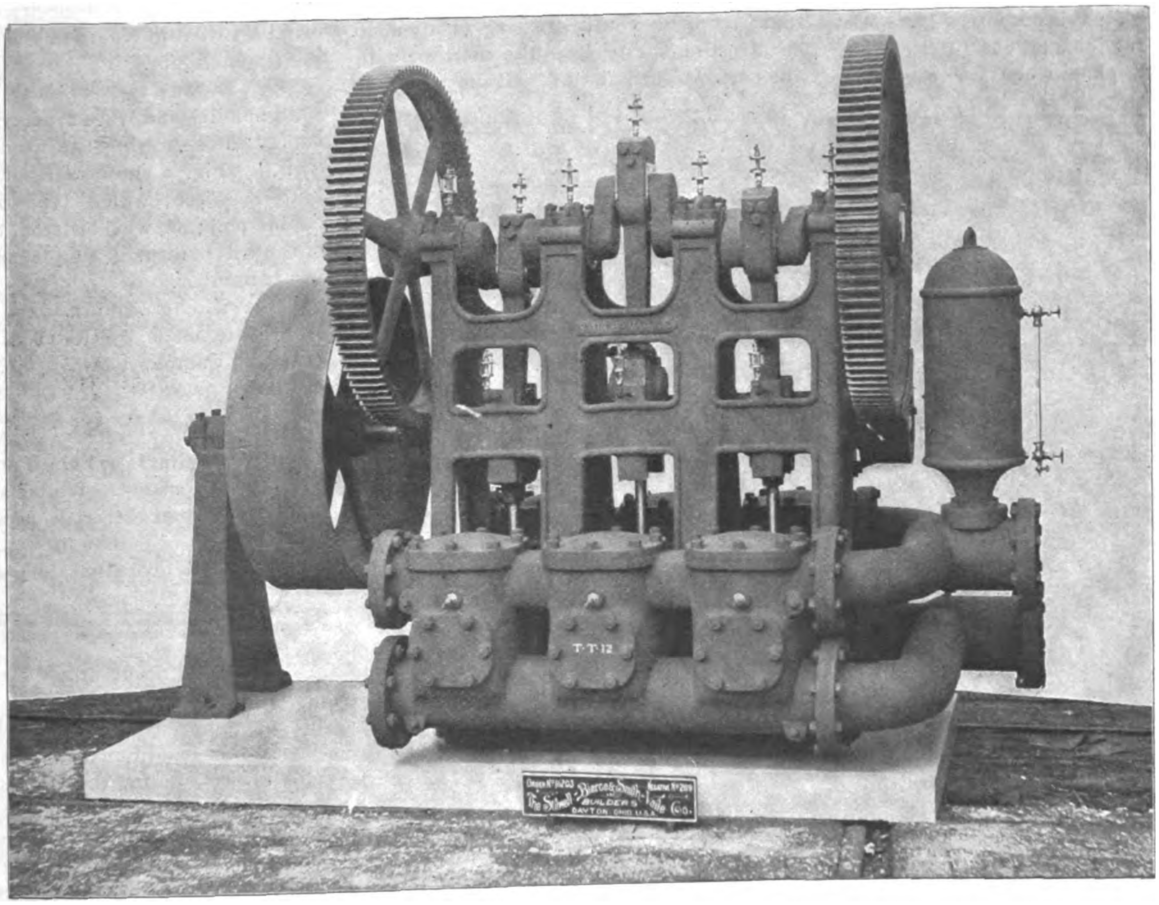
The armature is pivoted on a brass pin, which passes through holes drilled in the armature and into brass supports; this gives an easy positive movement, a clean stroke free from any wabbling, and always keeps the contact rivet against the contact screw point. This construction, also, allows the heel of the armature to be brought very close to the core without touching it, thus utilizing the full power of the magnets, and at the same time preventing the possibility of the armature sticking.

The contact and adjusting spring is made of one piece of phosphor-bronze spring. This gives a perfectly balanced armature movement, and a simpler and more positive adjustment than can be otherwise obtained. The gong cannot turn or loosen, and is therefore always in striking position. The hammer rod is formed from spring wire, always retains its shape, and will not get loose either in the armature or hammer. The cover is made of cast-iron neatly japanned both inside and out, and is held firmly in place by a German silver spring.

The bell above described, known as the "Improved B. B. Iron Box Bell," is made by the Central Electric Company, Chicago.

ELECTRIC PUMPING.

The application of electric power to pumping service is coming more and more to the fore. Thus far most of the electric pumping plants have been installed in the West, where their advantages were early recognized, but knowledge of these advantages and of the opportunities which electric pumping offers for leveling the load line, is becoming more general, and there is every prospect that this application of electric power will soon become widely extended. In New York City it has been found profitable to sell electric power in large quantities at less than four cents per HP-hour, notwithstanding the enormous cost of the underground distributing system. In localities where coal is cheap, and with a rational system of charges instead of the usual system that makes no allowance for long-hour heavy service, even small plants should be able to sell current during hours of light load at a cost which would enable it to be used for pumping purposes.



TRIPLEX PUMP.

Manufacturers of pumps have been awakened to the possibilities of electric pumping, and one of the newest designs of a triplex pump specially applicable to such service is illustrated herewith. Among the features in this pump which are new is the use of four standards, giving four bearings for the crankshaft—in other words, giving the piston connections a bearing on each side. The piston rods are guided by cross-heads with adjustable brass shoes, in this way preserving a perfect alignment at all times and insuring that the stuffing boxes will not cut.

Another feature is that the cylinders are cast separate from the pump, thus being removable and enabling a new cylinder to be supplied at any time. The frame is raised high enough above the pump so that the parts are easily accessible for packing; a piston packing is used with this type of pump, as it is believed to be the best for the service. The valves are given a very large area, which allows a high speed without any undue fluctuations or hammering. All the valves seats are made of composition and are screwed in place. Where thick liquid is used and in "stuff" pumps, the valve chambers are altered somewhat, and ball valves are used. The gear is cut gear, and for pressures of 150 lbs. and above are beveled gears; for 80 lbs. and below a single gear is used.

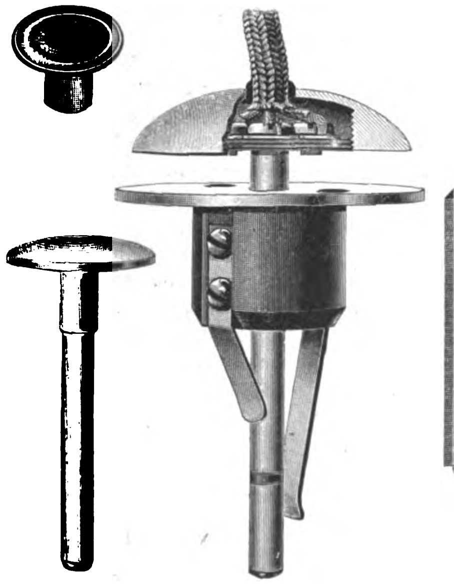
The motor is mounted on a base flanged and bolted to the pump base, thus making an alignment which is perfect. The shaft is provided with ring oilers, and the crossheads have oil packings. The cranks are of steel, and the piston-rod boxes are of the regular engine type.

FLOOR PUSH.

Among the class of electrical appliances known as "electrical house goods" there is no article which has given as much trouble to user and electrician as combination floor pushes. In the position where they are generally used, under dining room tables, they are very liable to be broken when the table is moved to one side to clean the rug.

To obviate this liability, the push shown in the illustration has been devised, its special advantages being that it is impossible to break the top, owing to its rounding shape, which allows a table leg to roll over it without doing any damage. If the cord is pulled hard, it will not break the small conducting wires, because a knot can be made in the flexible cord under the cap, or a special cord used, as shown in the illustration.

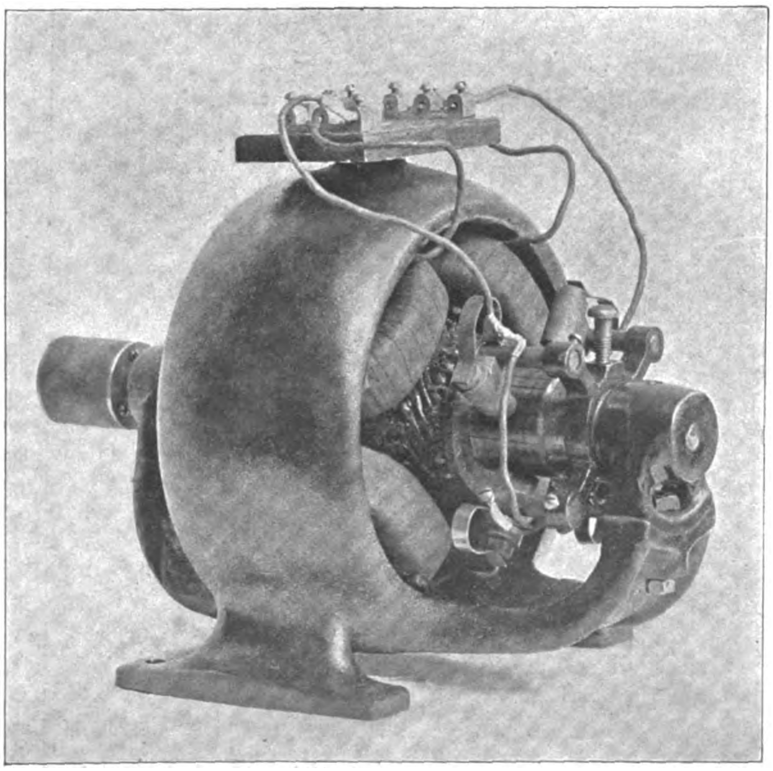
Only one hole is required in the floor plate for both plugs, which in use pass through an eyelet that has been pressed through and easily fastened in the carpet or rug without breaking the strands, by a tool made specially for this purpose. The eyelet used in the rug enables one to easily find the floor-push plate when the rug is replaced after cleaning. The portion inserted in the floor is securely held, as it exactly fills the hole. The distance between floor plate and top is adjustable, and a rubber bushing is used where the cord passes through the cap.


FLOOR PUSH.

This push, known as the "Dandy Floor Push," is manufactured by The Electric Gas Lighting Company, 195 Devonshire Street, Boston.

A DYNAMO FOR EXPERIMENTAL PURPOSES.

The illustration herewith shows a new design of dynamo for experimental purposes, manufactured by the Institute for Home Study of Engineering, of Cleveland, O., for its students. Though especially adapted to experimental work, it is also a commercial machine, the idea in furnishing such an apparatus being that after the student has finished his course he can use it for a practical purpose. When the student reaches that part of his course treating of dynamo construction, he receives the machine with the parts finished and with all the materials for winding; the work of making the armature complete, putting on and connecting the field coils, is a part of the electrical course of the Institute. When completed, the student uses the machine experimentally during the remainder of his course.


DYNAMO FOR EXPERIMENTAL PURPOSES.

The illustration shows the machine complete. The armature is of the drum type with laminated core. The commutator is long in order that collector rings for taking off currents uncommuted, and in from one to three phases, may be slipped on it, together with the new set of brushes required. When operated as an alternating-current machine, it excites its own fields.

The range of experimental use is wide, and teachers of electricity find that the practice of winding and connecting the machine is of great value to the students.

FLUSH SWITCHES.

The accompanying illustrations show several types of flush switches that during the past year have been finding much favor among contractors and electricians who demand a switch in regard to whose reliability there is no doubt.

Fig. 1 shows a type of flush switch with solid handle, and Fig. 2 a key switch with an indicator showing the words "on" and "off." Fig. 3 shows a single-pole push-button switch, which type is also made double pole; as will be seen, the principle of the mechanism is simple, and the parts few in number.

These switches, known as the "New England," are made by the O. S. Platt Manufacturing Company, Bridgeport, Conn.

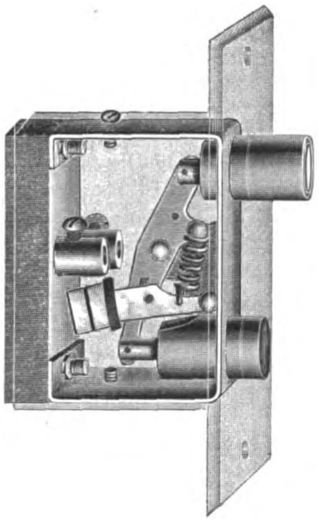


FIG. 1.—PUSH-BUTTON SWITCH.

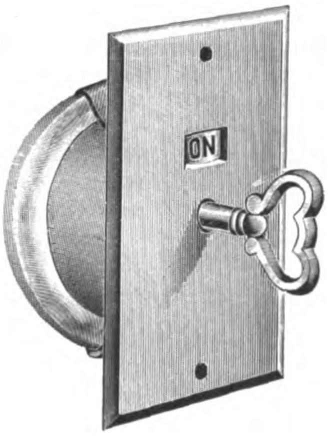


FIG. 2.—KEY SWITCH.

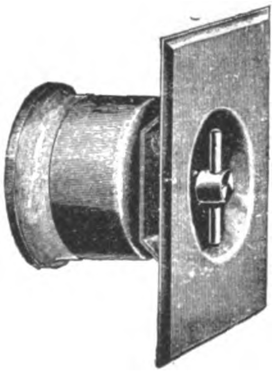


FIG. 3.—FLUSH SWITCH.

A NEW ARC-LIGHT CARBON.

Where steadiness of light is an object, and for use on constant-potential arc lamps, an expensive cored carbon is necessary. The grooved type of carbon herewith illustrated is claimed to give all of the good results of the much more costly cored carbons, and to possess the additional advantages of not only always holding the arc in one position, but, of exposing a maximum area of crater, the illumination from which is directed at the most desirable angle, and not downward as in the case of the central crater. In addition, the grooved carbon is claimed to prevent clinkering. Even with the best German carbons a clinker will occasionally build up on the lower pencil until it comes in contact with the upper one, when the light flickers or goes out. With the grooved

GROOVED ARC-LIGHT CARBON.

carbon, this clinker, when it appears, approaches the upper pencil where the groove has cut away the carbon, which, therefore, offers no point of contact; the feed of the lamp preventing an approach, under these conditions, sufficiently close for contact.

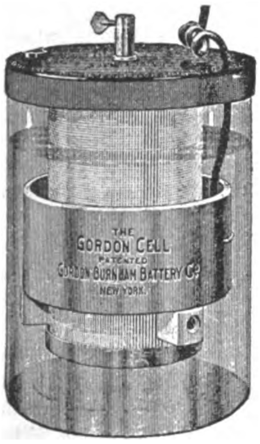


FIG. 1.—GORDON CELL.

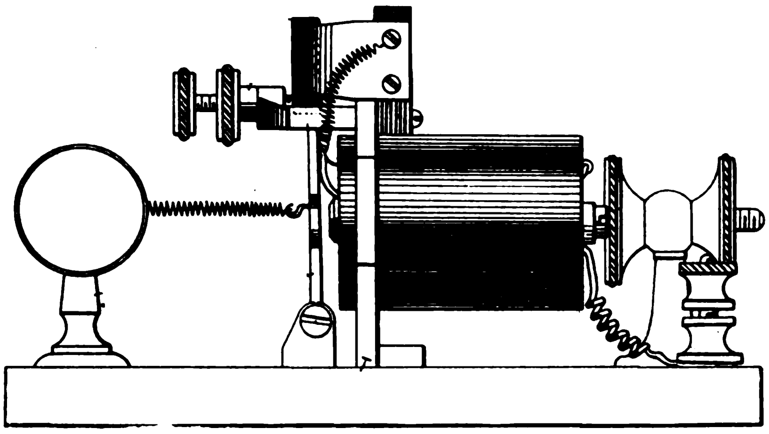


FIG. 2.—BANKS AUTOMATIC RESISTANCE INSERTER.

The carbon, as will be seen in the illustration, has a groove running laterally from end to end. In one style, used for general purposes, the groove is only sufficiently large to open the crater and hold the arc in position. The other is a "focusing" or larger groove, and is suitable for use in railway yards, shop windows, or wherever it is desired to throw the light in a definite direction.

The grooved carbon is used for the upper pencil, and in about two minutes after starting up, permanently adjusts its crater, all of the surface of which is effective in producing light. For general lighting, the carbons register axially; when a focused light is required, the groove is turned toward the objective point, and the lower carbon set slightly in front.

The new type of carbon described is made by the Open Arc Carbon Company, Downing Building, New York.

GORDON PRIMARY BATTERY, AND BANKS AUTOMATIC RESISTANCE INSERTER.

The old form of blue-stone gravity battery was defective in so many respects that its use was limited to the special conditions of telegraphic work, where a high internal resistance and low-rate current were not objectionable. The new form of alkaline cell herewith illustrated possesses none of these disadvantages of the old type, and is claimed to be superior to other primary cells in that it cannot be polarized under the most severe closed-circuit work, a constant current being maintained until the elements of the cell are exhausted. Its commercial E. M. F. is from .65 to .75 volt under working conditions, and it has been known to hold its voltage until an output of 375 ampere-hours or 250 watt-hours have been drawn from the elements contained in a 6 in. × 8 in. jar.

The negative element consists of a perforated tin cylinder filled with black oxide of copper, which is a powerful depolarizing agent. Three porcelain lugs or cleats are attached to the lower part of the tin cylinder, upon which rests a rolled-zinc cylinder 5½ ins. in diameter, 2½ ins. wide, and containing 1½ lbs. of chemically pure zinc amalgamated by a special process. The internal resistance of this cell is from .04 to .06 ohm.

The solution used is an alkaline technically known as electro-sodium, which will not freeze or be chilled at winter temperatures as low as 25 to 30 degs. below zero, Fahr.

These cells are largely used in the telegraph and other services of the Federal Government, by various large railroads telephone and telegraph companies, and in the fire and police telegraph departments of a large number of cities.

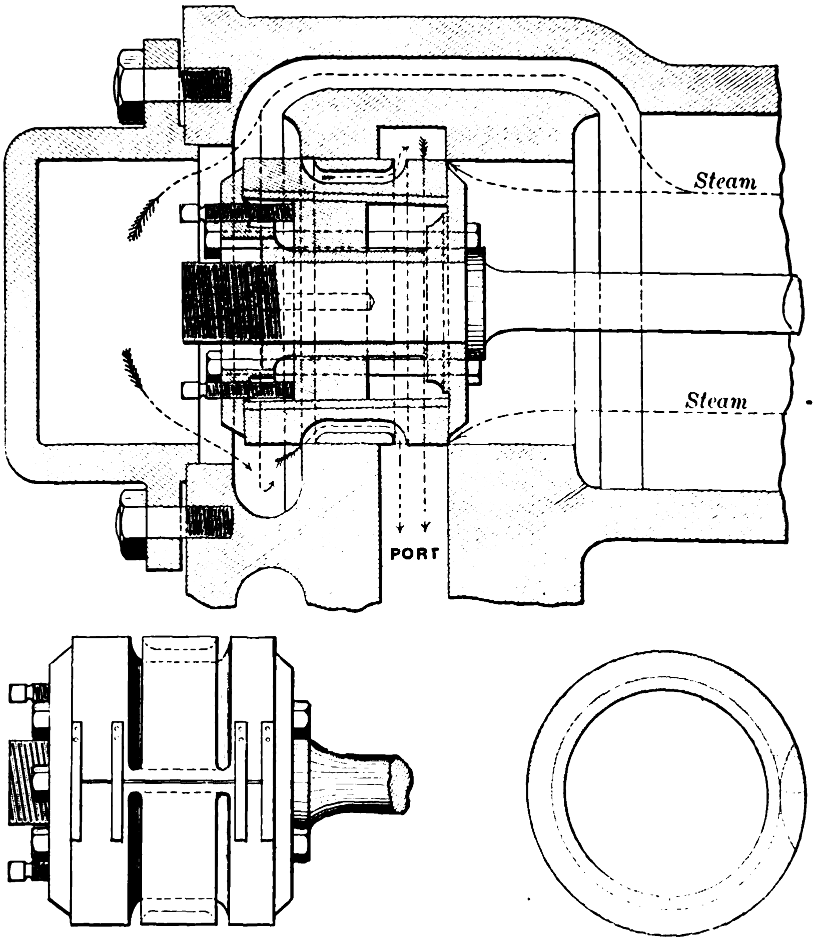
When used in block-signal work, on account of the low internal resistance of the cell, the current is apt to be excessive when a train of cars is on the block. In order to overcome this objection, Mr. Banks, the electrician of the Gordon-Burnham Electric Battery Company, has perfected a device which automatically keeps down the current discharge to an amount necessary to work the signal service. This device is illustrated in Fig. 2. There are two coils, one a primary and the other a secondary. The primary is of low resistance and the secondary coil, which is normally cut out of circuit, and only cut in when a train comes into the block, is of the same resistance as the relay used under normal conditions for operating the signal circuit.

When a train comes into the block, an excessive current starts to flow through the primary coil, which attracts an armature and throws into series with the batteries the resistance of the secondary circuit, which remains there until the train runs off the block, upon which the armature falls back into its former position and thus throws again into circuit the primary coil.

The primary cell and Banks automatic resistance inserter above described, are manufactured by the Gordon-Burnham Battery Company, 82 West Broadway, New York.

THE FITCHBURG VALVE.

The valve shown herewith, used on the Fitchburg engine, is notable in several respects. It is perfectly balanced and its construction is such that all wear is taken up, the makers guaranteeing the valve in this respect for twenty-five years. The details are excellently shown in Figs. 1 and 2, and it is only necessary to note that by removing the bonnets, which have ground joints,



FIGS. 1 AND 2.—FITCHBURG VALVE.

the valves are easily accessible. By slacking the bolts bearing on the head of the valve and tapped into the center plug, then tightening those tapped through the head and bearing against the taper plug, the latter is forced in and the valve expanded in diameter to any amount desired, from $\frac{1}{10000}$ in. up to $\frac{1}{16}$ in. The makers state that an hour's attention once a year will keep the valve steam-tight during the life of the engine.

The valve motion is shown in Fig. 3. The wrist-pin actuating the valve travels in the concentric arc of a cam, without moving it during more than half of its travel, then gradually starting the valve until its edge reaches the edge of the port; the form of the cam is such that the valve is then thrown open suddenly, remains open until cut off, and is then suddenly closed. The steam port is thus opened and closed swiftly, the valve only traveling as far as is necessary to fully open the port and then returning to its rest, when the valve at the opposite end opens and closes in its turn. The point of cut-off is automatically varied from nothing to two-thirds stroke with, the manufacturers claim, absolutely even speed.

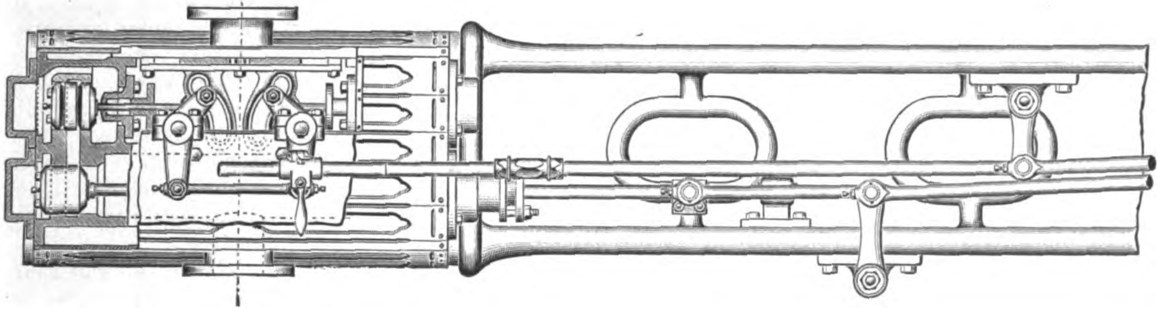


FIG. 3.—VALVE MOTION, FITCHBURG ENGINE.

The double-ported valve used and quickness of opening and closing of the valve with this gear, necessarily gives as clean an admission and cut-off as is obtained by the most efficient releasing valve-gear, with the advantage that the complications of the latter are avoided. With this valve motion a speed can be obtained ranging from 70 to 200 r. p. m. with perfect satisfaction, and with no noise, there being no dash-pots or clicking or catching of releasing gears.

IMPROVED ROBERTSON-THOMPSON INDICATOR.

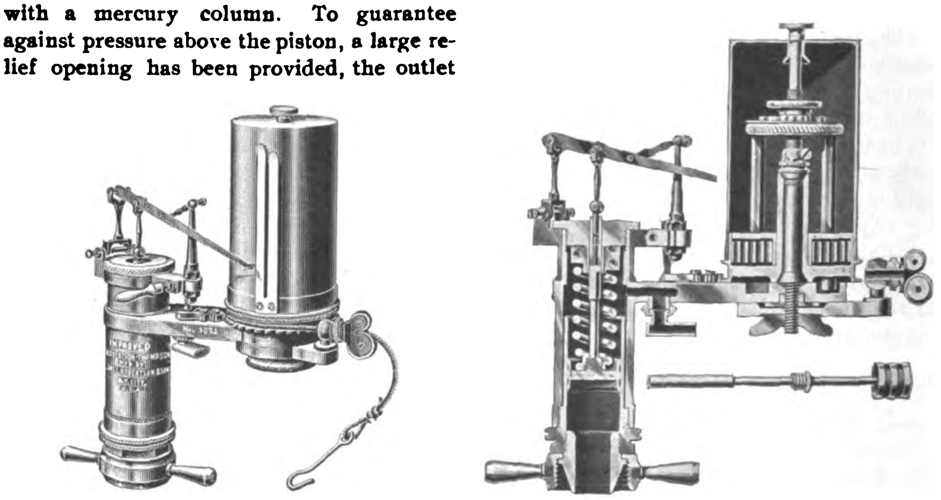
The improved Robertson-Thompson indicator, which has just been placed on the market, is unusually heavy, but as a result of most careful experiment this weight is so perfectly distributed that the best results may be attained at speeds far in excess of any met with in actual practice. One of the most serious errors in ordinary indicator work is caused by flexure of the arm which carries the drum, particularly when the cord is carried above or below the instrument. In this manner an error of 10 per cent. is easily possible, particularly if the instrument is being used with a high-pressure spring. For instance, with an 80 spring, it would require a movement of but $\frac{1}{80}$ in. to show an error of 1 lb. In many cases weakness at this point will account for the curious features often noticed at the junction of the admission and steam lines on the diagrams. The drum-carrying arm of the improved Robertson-Thompson indicator is so stiff that no error from this cause is possible.

The cylinder is steam-jacketed, and by its construction the possibility of the piston being cramped as a result of external strains is precluded. The area of this cylinder is exactly ½ in., and each spring is suitable for twice the pressure stamped on it; for instance, a 60 spring may be used for a pressure of 120 lbs. or less. The coupling is reamed to ¼-in. area, and with each instrument an extra ¼-in. piston is furnished, as shown in Fig. 2. With this piston each spring may be used for pressures four times as great as the number stamped thereon, so that with a 60 spring 240 lbs. may be safely indicated. This extra piston is of special value for hydraulic and gas-engine work. The pistons are made of steel, but phosphor-bronze will be substituted if preferred. The piston springs are standardized by the most approved testing apparatus, in connection with a mercury column. To guarantee against pressure above the piston, a large relief opening has been provided, the outlet being a neat swivel elbow, by means of which the "blow" may be discharged in any direction, at the will of the operator. Each instrument is provided with a detent or stop motion.

In Fig. 3 a new device is shown for adjusting the tension of the drum spring. By rotating the knurled head, *S*, to the right, the spring may be tightened as much as desired, and securely held by pawl, *P*; the ratchet wheel, *N*, is securely attached to the shaft by means of a left-hand thread. Thus the tendency of the drum spring is to tighten this ratchet nut more firmly. By pressing the thumb in to the recess in the spring winder, *S*, the pawl is released, when the tension may be diminished to any desired amount. This ratchet wheel has 16 teeth, which provide for the adjustment of the spring to a nicety. Drum springs are of the clock type, but spiral form will be furnished if preferred. Cone bearings are provided to take up all wear of the drum spindle. The parallel movement is made of tool steel, highly polished and richly blued. All bearings are wide and perfectly fitted.

All moving parts are worked down to the lightest weight consistent with durability. For comparison, it may be stated that the drum weight is but 1¼ oz., and the pencil lever 25 grs.

By special order the instrument is fitted with improved Victor reducing wheel, which comprises the usual cord-feeding device. The manufacturers are James L. Robertson & Sons, No. 204 Fulton Street, New York.



FIGS. 1 AND 2.—ROBERTSON-THOMPSON INDICATOR.

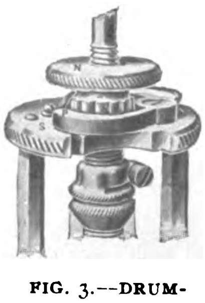


FIG. 3.—DRUM-SPRING ADJUSTING DEVICE.

AUTOMATIC WEIGHING MACHINES.

The accompanying illustrations show two classes of weighing machines made by the Pratt & Whitney Company, one being a gravity and the other a power machine. The former is applicable for weighing materials which spout freely, such as all kinds of grain, coffee, etc., while the latter is especially adopted for checking the weights of coal when received, and ascertaining the amount consumed daily in steam generation.

The machines are built upon the interlocking principle, which makes it impossible for both the supply valve and bucket closer or discharge valve to be open at the same time, thus preventing the material from going through the machine without being weighed and the weight registered. For example, if the supply valve in the receiving spout is open, letting the material into the bucket, it is impossible to open the bucket closer, and remove the material until the entire amount the machine is set to weigh has passed into the bucket. At this moment the supply valve closes automatically while the bucket closer unlocks, and the interlocking device connected with the latter passes behind the interlock on supply valve; the supply valve cannot, therefore, open until the bucket is closed, and *vice versa.*

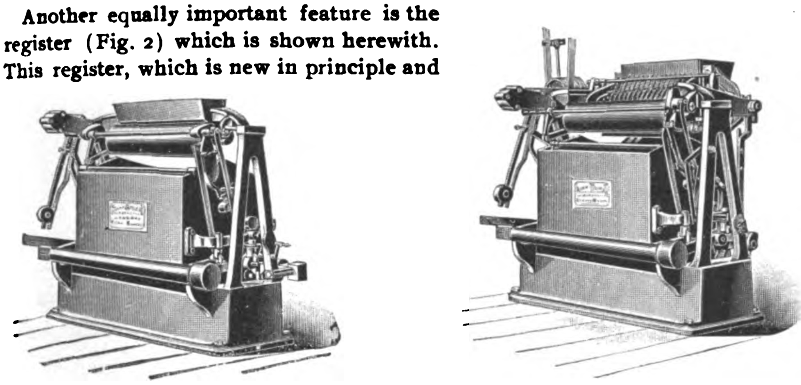


FIG. 1.—AUTOMATIC WEIGHING MACHINE.

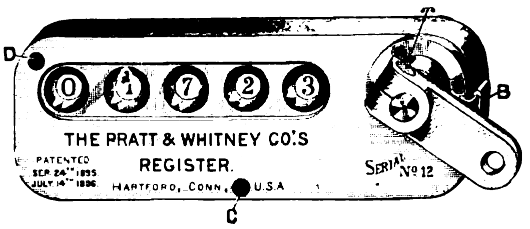


FIG. 2.—WEIGHT REGISTER.

Another equally important feature is the register (Fig. 2) which is shown herewith. This register, which is new in principle and design, is so connected with the bucket closer of the machine that it has a positive motion each way, and when the closer opens and closes, it registers one only, it not being possible to count more than one at a time with the two movements of the closer.

The machines are so constructed that in addition to the regular counter or register, an additional "stop-motion" register can be attached and set to weigh a given quantity or a specified number of drafts. When that number has passed through the machine, it will stop and remain in that conditon until the "stop-motion" register or counter is adjusted and the machine started off again, making it possible to weigh two or more different component parts of a fuel mixture.

The "power-feed" machine is practically the "gravity" scale with the addition of a feeder arrangement for delivering the material into the bucket. This feeder or supply apparatus, is an endless belt or conveyor, composed of a pair of drive chains and a series of overlapping slats, or bars, pivoted at one end to the chain links. On the upper side of the conveyor the bars lie flat to form a continuous surface, but on the lower or return side the bars swing down and so leave openings for the escape of any material that may have accumulated within the conveyor. The feeder belt is operated by belt-driven shafts and gearing having two speeds.

When a load has been discharged, the return movement of the bucket closer shifts the driving belt on to the high-speed pulley which then operates the conveyor, rapidly supplying material to the bucket, until a major part of a load has been received therein. Then the bucket partially descends and shifts the belt for slowly operating the feeder on to the slow-speed pulley for supplying the "drip" to complete the load. When the weighing mechanism is thus brought to a true poise, the feeder is instantly thrown out of action, and a valve brought into position to retain any material that may accidentally pass over the discharge end of the feeder belt after the poising has been accurately effected.

The machines described are manufactured, in sizes ranging from 2 lbs. each to 2000 lbs., by the Pratt & Whitney Company, Hartford, Conn.

MULTIPOLAR ELEVATOR MOTOR AND AUTOMATIC CONTROLLER.

The accompanying illustrations represent the class "E" reversible, multipolar "Keystone" elevator motors and automatic controllers. The field frame and poles of the former are of open-hearth steel, which combines the desirable features of high permeability, lightness and strength. The illustration shows the method of removing the field coils without taking out the armature, a very desirable feature in elevator work. The field is compound wound, all four poles having shunt coils, which are interchangeable. The end coils, which are longer, have series coils in addition to the shunt coils.

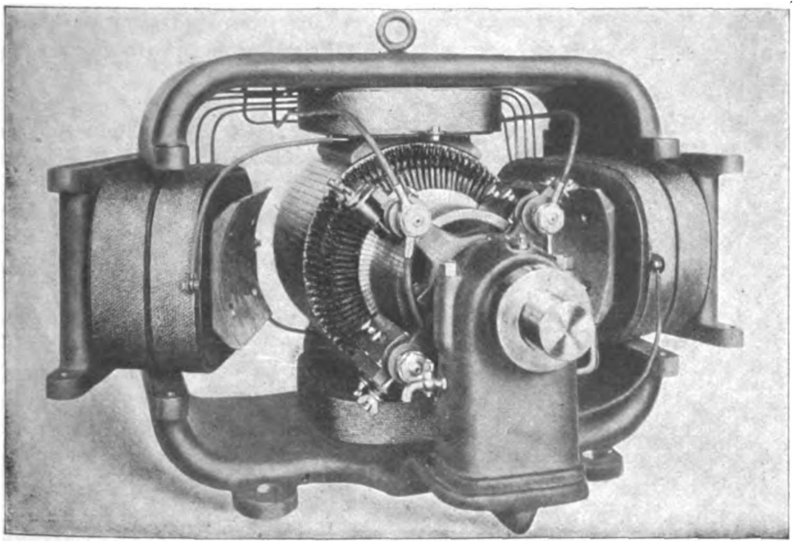


FIG. 1.—KEYSTONE ELEVATOR MOTOR.

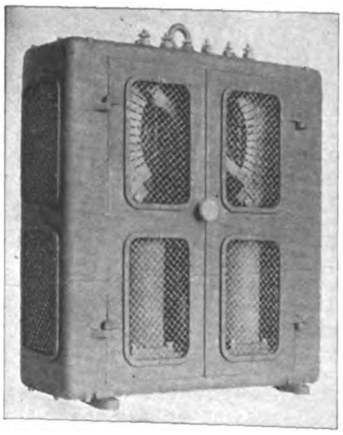


FIG. 2.—AUTOMATIC CONTROLLER.

The series coils are very much larger than in the ordinary compound-wound motor. The effect of these coils is to produce a very strong field and large starting torque immediately after the switch is closed for starting the motor, thus reducing the starting current. They are automatically cut out after the resistance in the automatic rheostat has been cut out and the motor has nearly attained its full speed. The shunt coils are of ample strength to operate the motor after attaining speed, and give a nearly constant speed for varying loads. In this manner are combined the advantages of a series motor for starting, and a shunt motor for operating after speed is attained.

The armature is Gramme-ring wound and of the iron-clad type with overhanging teeth, no binding wires being required. This permits of quick and easy repairs, and without removal of commutator if it is necessary to renew but a few coils. These motors are manufactured in sizes varying in capacity from 6 HP to 54 HP.

The automatic controllers are made in sizes to comform to the different sizes of motors. The principal features of these controllers are compactness, perfect ventilation, neatness of design, large number of contact plates and reliability under the most severe duty.

Among the large installations may be mentioned the American Lithograph Building, corner Ninteenth Street and Fourth Avenue, New York City, in which there are eight 30-HP motors in successful operation. The manufacturers, the Keystone Electric Company, Erie, Pa., have nearly 1000 motors in successful operation on elevators in different parts of the country.

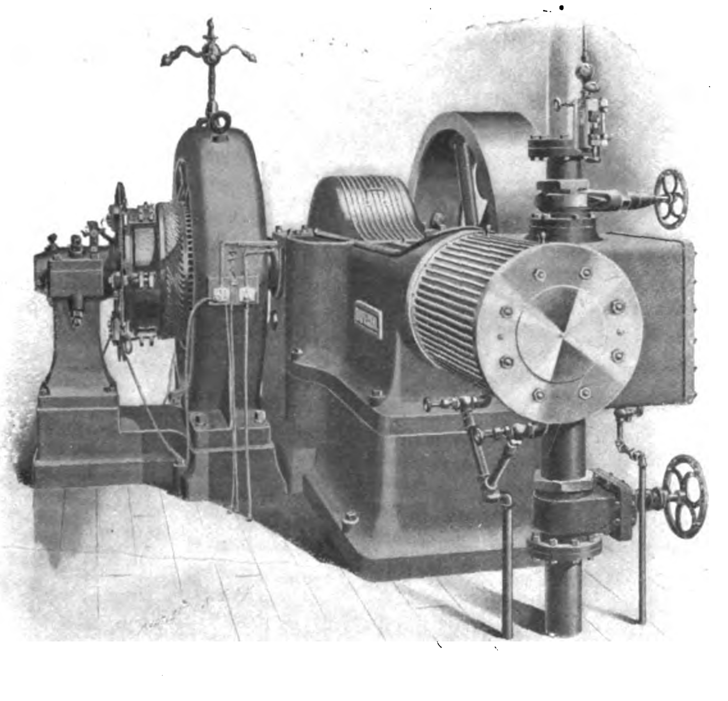
THE WESTON ENGINE.

The accompanying cut shows a 14 in. × 14 in. Imperial engine, which was exhibited at the recent Tennessee Centennial and awarded a silver medal. The engine is shown direct-connected to a 75-KW Triumph generator. The Imperial engine is of the center-crank automatic type, and is built for high and medium speeds. The engine is self-oiling; a partition plate prevents the oil in the crank case from coming into contact with the heated cylinder. The valve is double ported and balanced by means of a pressure plate, which is recessed with four openings to correspond with the ports of the cylinder. Between the pressure plate and steam-chest cover is a coil spring so placed as to allow the valve and plate to lift from the valve seat should the cylinder receive a charge of water.

The cross-head is of a new design and possesses the unusual features of fitting together in correct alignment and eliminating any possibility of the piston rod getting loose and backing out. It is made in two longitudinal sections, being divided on the line through the center and parallel with the face of the guides.

A governor of the Rites type is used, consisting of but a single moving piece swung on a single supporting arm, the eccentric even forming an integral part of the weight construction. In this type of governor, it will be remembered, the centrifugal element upon which the degree of refinement and regulation of all governors depends, is combined in the same piece with an inertia element relatively so great that instantaneous changes of load are provided for without waiting for centrifugal action. The most prominent feature, however, is the resistance which the exaggerated inertia offers to the disturbing action of gravity, a balancing weight being thus dispensed with and the whole governor reduced to a single piece.

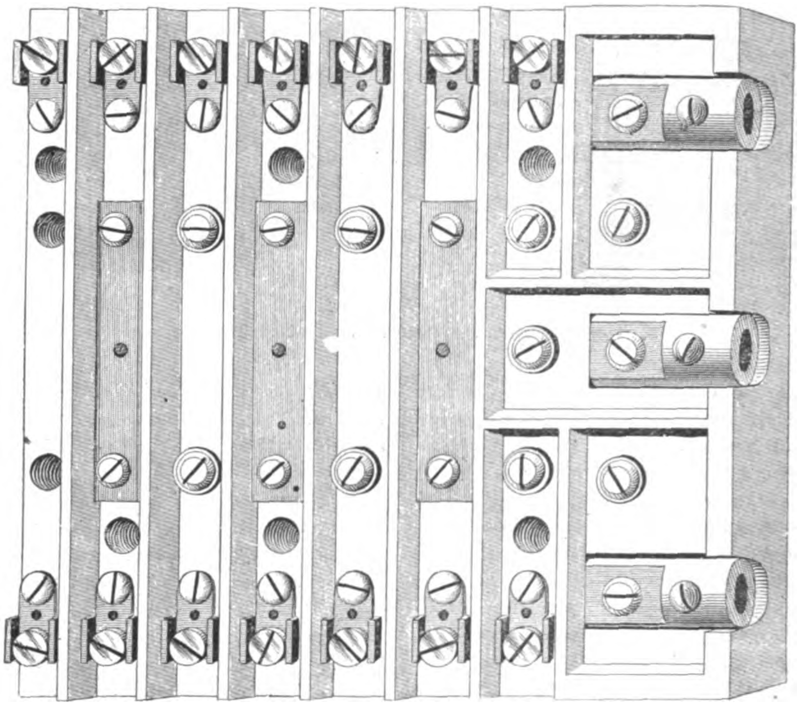
By means of this governor, remarkable simplicity and the most sensitive regulation are combined, a much greater uniformity of economy over the range of cut-off being thus available than was formerly possible. The Imperial engine is manufactured by the Weston Engine Company, Painted Post, N. Y.



IMPERIAL ENGINE AND TRIUMPH DYNAMO.

PORCELAIN-TABLET BOARDS.

The multiple-tablet form of switch-board has for the past several years come rapidly into use, and may now be considered to represent standard practice. A late type is illustrated herewith, designed for the three-wire system. The board is made of sectional pieces of porcelain and can be built for any number of circuits. The same type is also made for the usual two-wire circuit. The manufacturers are the Peru Electric Manufacturing Company, Peru, Ind.



PORCELAIN-TABLET BOARD.

BELT-DRIVEN RAILWAY GENERATORS.

So rapid has been the development of the railway generator directly connected to the driving engine, and so extensive its adaptation, that the railway public is apt to lose sight of the fact that the belt-driven generator is still greatly in demand. Many cases exist in which the conditions do not warrant the installation of direct-connected apparatus, and to these cases the belt-driven generator is more applicable.

Improvements in belt-driven generators have kept pace with those in all other classes of electrical apparatus, and the distinguishing features of excellence of the General Electric Company's direct-connected apparatus have been incorporated in its new line of belted machines. These are all six-pole generators, built in five sizes ranging from 110-KW, to 500 KW. That shown in the illustration is a 110-KW, six-pole, 500 revolution machine.

The magnet frame is of cast-steel heavily ribbed, making it both light and compact. Its magnetic efficiency is the highest obtainable. The bearings, which are built upon the ball-and-socket principle, are self-aligning and self-oiling The steel poles and pole pieces are cast in one piece and so bolted to the frame that they may easily be removed without disturbing either the armature or the frame.

The series winding of the field coils is of flat copper ribbon, the shunt winding of wire. Instead of winding the series coil on the field spool and covering it with the shunt winding, both windings are placed side by side on the pole, and being entirely independent, either may be removed without disturbing the other. It is no longer necessary with this new method to remove the shunt winding to reach the series winding.

The armature is of the barrel-wound type, such as is used in the General Electric direct-connected generators. This method of winding gives the smallest number of joints, and facilitates any necessary repairs, as few coils need to be removed to reach any particular one incapacitated for service. The cast-iron flange, bolted to the armature spider at each end of the core, forms a support as well as a cylindrical receptacle for the projecting ends of the coils. The coils are secured firmly in the slots of the core, and the cross connections are made on the barrel flange. The projecting ends of the coils in the flange are thoroughly insulated and held in place by steel bands. The flange extension also protects the windings from any oil that may be thrown from the bearings. The surface of the interior of the armature is perfectly smooth, offering no opportunity for the collection of oil or dust.

Ventilation is effected by the use of specially constructed vanes forming air ducts between the laminæ of the core. These convert the armature into a blower, and create a strong draft through the windings. The commutator leads are taken directly from the coil to the segment immediately beneath it. The construction of the commutator is similar to that of the direct-connected machines. It is ventilated by air drawn through the body and discharged through air ducts in the core. The small difference of potential between the segments secures the permanence of the insulation and freedom from sparking.

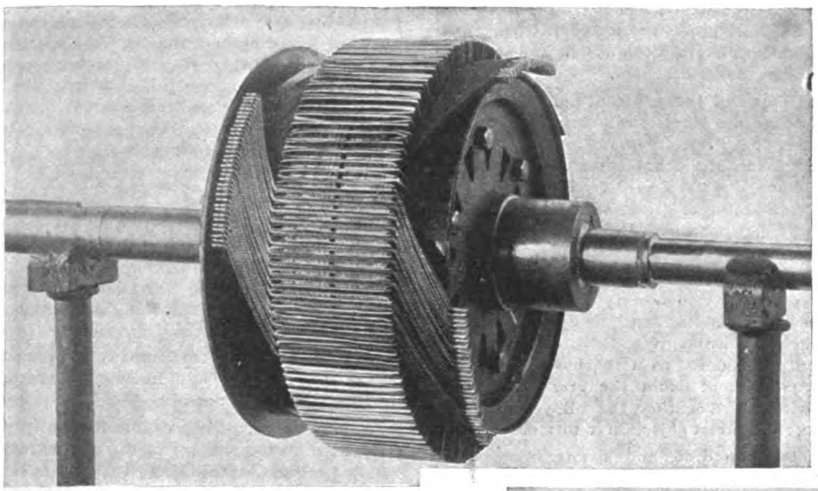


FIG. 1.—ARMATURE, PARTLY WOUND.

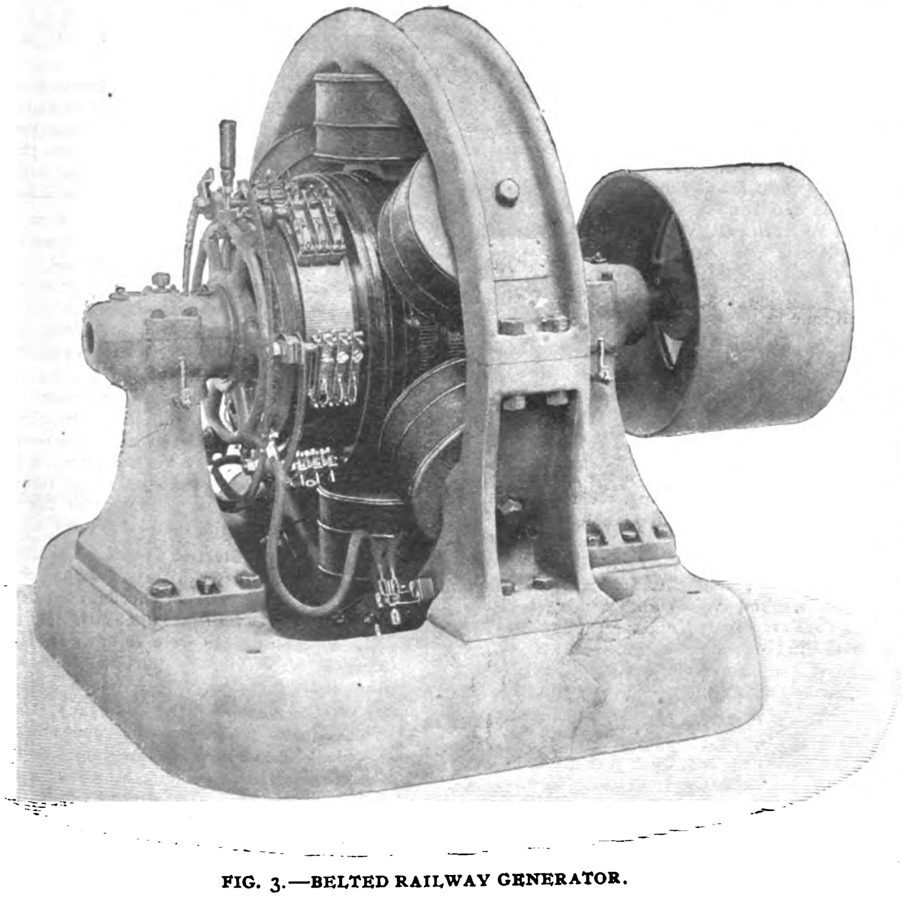


FIG. 3.—BELTED RAILWAY GENERATOR.

The strength of the magnetic field in these generators is so proportioned to the armature reaction that a constant brush lead and neutral point are ensured even with heavy overloads. These G. E. belt-driven generators have only been recently introduced, but up to Oct. 1 over fifty-five machines have been sold, aggregating considerably over 10,000 KW.

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NEW BOOKS.

PATENTED TELEPHONY. A Review of the Patents Pertaining to Telephones and Telephonic Apparatus. Chicago: American Electrical Engineering Association. 102 pages, illustrated. Price, $1.50.

To telephone manufacturers, owners of independent telephone exchanges, and all who wish to know the present situation with respect to telephone patents, this book will be invaluable. It is also a useful work technically, as all of the important details of switch-boards and other exchange apparatus are described and illustrated—in many cases for the first time outside of patent specifications and court records.

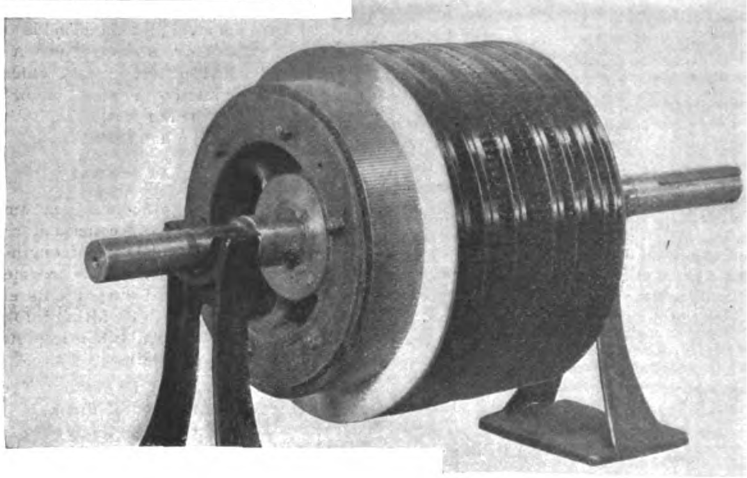

FIG. 2.—FINISHED ARMATURE.

THE MOTOR ENGINEER'S AND ELECTRICAL WORKER'S HANDBOOK. By Wm. Lintern. West Park, O: Wm. Lintern. 150 pages, illustrated. Price, 75 cents.

This is a book of instruction and reference in pocket-book form for the use of motormen and electric railway men generally. In the first four chapters the elementary principles of electricity and electrical machinery are briefly referred to. The following chapter and Chapter VIII, are reprints of instructions for operating generators and car apparatus, issued by the Westinghouse Company. The electric motor is briefly considered in Chapter VI, and the following chapter is on the measurement and tests of electric-railway motors. Chapter IX and XI contain detailed descriptions of motor-car apparatus and wiring. Chapter X contains definitions of electrical terms, and the final chapter consists of general electrical and mechanical information. The book will be found of assistance by motormen and others connected with street railway operation, who do not care to take up the systematic study of the subject, but desire to obtain some information concerning practical details.

THE THEORY OF ELECTRICITY AND MAGNETISM. Being Lectures on Mathematical Physics. By Arthur Gordon Webster, A. B. (Harvard), Ph. D. (Berol). New York: The Macmillan Company. 576 pages, 101 illustrations. Price, $3.50.

The object of this work is to present to the student an introduction to the mathematical theory of electricity as built up by Faraday, Maxwell, Hertz and Heaviside. The treatise is intended for students and others who have studied the calculus and vector analysis. A considerable portion of the work is purely mathematical, the writer aiming to bring out the geometrical or physical nature of the processes involved before coming to their electrical application. Though not so easily read as Mascart and Joubert, it does not present the difficulties encountered in Maxwell and in Heaviside, and has the advantage of including much of the work of the latter and that of Hertz.

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PERSONAL.

Mr. Seth C. Adams has been appointed by the Walker Company to look after its interests in central New York, and has opened an office and will have his headquarters at Utica, N. Y. With an uneqaled acquaintance within his territory among the electrical fraternity, Mr. Adams will be able to render a good account in his new appointment.

Mr. George R. Blodgett, counsel in charge of the patent business of the General Electric Company, was killed by a burglar in his home in Schenectady, early in the morning of Dec. 3. Notwithstanding the offer of a reward of $5000 by the General Electric Company, and most strenuous efforts on the part of the local and other detectives, no clue to the murderer has yet been discovered. Mr. Blodgett was born in Bucksport, Me., in 1862, and graduated from Yale in 1884. Soon afterwards he was appointed an examiner in the United States Patent Office at Washington. During his residence at the National Capital he studied law and was admitted to the bar. In 1888 Mr. Blodgett became one of the counsel of the Thomson-Houston Electric Company, and in 1893 his services were secured by the General Electric Company, and he removed his headquarters to Schenectady the following year. Mr. Blodgett attained a national reputation as a patent practicioner at a much earlier age than eminence usually comes to the lawyer, and, had his life been spared, he would undoubtedly in time have become an acknowledged head of that branch of the legal profession.

Mr. E. J. Wessels, who has been so strongly identified with the interests of the Standard Air-Brake Company since its formation, has resigned his position with that company as managing director, to take effect on Mar. 1. The retirement of Mr. Wessels from this field is a great loss, as it was through his ability, energy and persistence that the electric railway brake was advanced from a crude experimental stage to its present perfected form, with an automatic electrical control which makes the apparatus entirely independent of the motorman beyond the mere manual manipulation of a single handle. The activities of Mr. Wessels were not confined to this country, but extended to Europe and even to Australia, hundreds of air brake equipments having been introduced by him abroad. A potent factor in Mr. Wessels' work of bringing the electric railway brake to the front was his skill as a writer of advertisements, in which he has been unequaled in the entire electrical field, and referred to in high terms by *Printers' Ink*, the authority on advertisement writing in general. In whatever field Mr. Wessels' future labors may lie, he will undoubtedly be a great force.

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TRADE PUBLICATIONS.

Triplex Pumps. The Stilwell-Bierce & Smith-Vaile Company has in press a very complete catalogue devoted exclusively to triplex pumps, which will contain a large number of half-tone cuts of pumps of different styles, accompanied by much matter of technical interest.

Electrical Specialties. McLeod, Ward & Company, 27 Thames, Street, New York, in a recently issued catalogue illustrate and describe a number of their specialties, consisting of desk, portable, orchestra and electro-calcium lamps, safety wire holders and spark arresters.

Recording Instruments. Catalogue No. 2 of the Bristol Company, Waterbury, Conn., has for its subjects pressure, temperature and electrical recording instruments. All of the principal types are illustrated in detail, among others the Bristol recording vol meter, ammeter and wattmeter.

Walker Apparatus. A trade publication on luxurious hand-made paper with deckeled edges, is unusual even in these days of luxurious catalogues. The type "S" Walker solenoid blow-out controller furnishes the subject of the publication, which would in any event deserve especial mention from the beautiful design of the cover.

Steam Engines. In a recent catalogue the Fitchburg Steam Engine Company, Fitchburg, Mass., describes in detail the latest type of "Fitchburg" automatic variable cut-off steam engine, which embodies all the latest advances in the design of this class of engine. Those interested in the refinements of modern engine designs will find much in this pamphlet to instruct them.

Special Types of Incandescent Lamps. In a 42-page catalogue, the American Endoscopic Company, Providence, R. I., illustrates many forms of surgical, dental, miniature and other battery lamps, including telephone, bicycle, stereopticon and theatrical lamps. Many kinds of special series lamps for decorative and sign work are also illustrated, as well as different kinds of Röntgen ray tubes.

Electricity Direct from Heat. The Cox Thermo-Electric Company, 120 Liberty Street, New York, describes in a well illustrated pamphlet the Cox thermo-generator, and gives full directions for its operation. Considered as a thermo-pile, this apparatus is without doubt the greatest advance made during a half century, the alloyed junctions obviating the gravest objection to former types.

Fans. One hundred and twenty-four octavo pages are required to describe and illustrate the numerous types of steel-plate fans, made by the B. F. Sturtevant Company, Boston, Mass. A number of pages are devoted to electric fans, which are of large size and operated by a special motor forming a structural part of the fan case. The book is well printed and bound in a handsome cover of special design.

Steam Engines. The Weston Engine Company, Painted Post, N. Y., gives in a handsome and artistic catalogue, a well written and concise description of the Imperial engine. This type of engine, though but a few years on the market, has become a standard machine for electrical purposes, its admirable regulating qualities especially fitting it for this use. The governor, as well as all other important features, are illustrated in detail.

Engines and Multipolar Dynamos. The American Engine Company, Bound Brook, N. J., has issued two handsome catalogues, one having for its subject multipolar dynamos and electric motors, and the other American Ball engines. The latter has covers of particularly good artistic design, and both publications are profusely illustrated. The detail sketches of dynamo winding in the dynamo catalogue will be found of much interest by electricians.

The Victor Turbine. In a well illustrated and printed pamphlet of 150 octavo pages, the Stilwell-Bierce & Smith-Vaile Company, Dayton, O., describes in detail and in all of its forms, the Victor turbine, and incidentally gives sufficient information on hydraulic power construction to entitle the work a rank among technical treatises. The illustrations number not far from 200, those executed in half-tone being in quality much above the average seen in trade publications.

Indicators and Steam Gauges. A substantially cloth-bound octavo volume of 173 pages, issued by the Crosby Steam Gauge & Valve Company, 97 Olive Street, Boston, is an admirable example of a class of trade publications which also have a high value as technical treatises on the subjects considered. Steam, water, vacuum, recording and test gauges, and for every use imaginable, are illustrated by excellent cuts, accompanied by well written descriptions and, where necessary, by instructions for use. Safety and globe valves, feed-water regulators, lubricators, pump valves and many other steam fittings are represented, and last, but by no means least, the Crosby steam-engine indicator, which is described and illustrated in minute detail, with directions for handling.

The General Electric Press. The productions of the General Electric Press (Schenectady) at present rank with the very best work turned out by firms making a specialty of the finest typography, engraving and press work. Three recent pamphlets—two on incandescent lamps and the other on the operation of electric mining plants—are beautiful specimens of the printer's art. The cover designs are exceptionally handsome, a remarkably fine effect being produced by a skillful color combination of paper and inks. The general catalogue of incandescent lamps consists of 66 8 in. × 10½ in. pages, and forms by far the best practical treatise on the subject of incandescent lamps yet printed—the great amount of useful information contained in the pages justifying the use of the word treatise. A smaller pamphlet on the same subject is devoted to incandescent lamps for isolated plants, a considerable portion of the contents consisting also of useful information on the selection and use of lamps. The pamphlet on the "Operaton of Electric Mining Plants" consists principally of data on the cost of working, based upon actual figures obtained from companies operating electric mining plants. A fourth pamphlet recently issued from the same same press, is on incandescent lamps for railway service, which describes the manufacture, selection and use of lamps for that service.

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BUSINESS NEWS.

Removal. Goldmark & Wallace have removed from 29 Chambers Street to 121 Worth Street, New York.

The American Stoker Company has removed its offices from Dayton, O., to Rooms 72, 73 and 74, Garfield Building, New York.

The Murray Iron Works, Burlington, Ia., have completed the foundations for the new 100-HP boiler, which they are installing at their plant in West Burlington.

Mr. Charles Wirt, of Philadelphia, has recently been in Chicago renewing old acquaintance, and bringing to the attention of the Western trade the new Wirt rheostat.

The Gisholt Machine Company, Madison, Wis., has applied for an electric-light franchise. It is the intention of this company to extend its present system, as it already has a plant which furnishes its works with light.

Dissolution of Partnership. The partnership heretofore existing between W. W. Burnham and James L. Gethins, doing business at 181 Tremont Street, Boston, under the name of the Burnham-Gethins Company, was dissolved on Nov. 24, 1897, W. W. Burnham succeeding to the business.

Alternating-Current Fans. The Western Electric Company has been made exclusive agent for the Tuerk alternating-current ceiling fan in the territory west of Pittsburgh. It has also been made exclusive agent for the car heaters and office-heating devices manufactured by the Globe Heating Company.

Fan Motors. J. P. Williams, 39 Cortlandt Street, N. Y., who has just returned from an extended trip through the West and Northwest, reports that his sales have been increased 40 per cent. over those of last year. He, therefore, considers that the prospect is promising for a very properous fan-motor season.

Mr. William H. Taylor, of the Chandler-Taylor Company, Indianapolis, has just returned from a trip to Chicago and the Northwest. He states that the business outlook is extremely good, and his company is preparing for an unusually busy season. It is already running at full capacity, and expects to add an extra force soon.

The Diamond Electric Company, 1202 Fisher Building, Chicago and Peoria, Ill., report trade conditions in much better shape than at any time during the previous year. It feels very much elated over the prospects for a splendid winter trade, and is using every effort to promptly fill the many orders which are coming its way.

Gas Engines for Electric Plants. The Otto Gas Engine Works, Thirty-third and Walnut Streets, Philadelphia, Pa., report an excellent business, especially in engines for running electric-light plants Two 110-HP gas engines were recently installed at Sistersville, W. Va., for this purpose, and two 50-HP engines at Mannington, W. Va.

The Vilter Manufacturing Company, Milwaukee, Wis., during the past year has done an exceedingly large business in Corliss engines. A number of nice orders for engines, etc., for delivery in the early spring of 1898, are already recorded. Inquiries continue to come in, and the company considers that the outlook for a good season's business is very favorable.

Recording Instruments. The great extent to which recording instruments have entered into use is illustrated by the fact that the Bristol Company, of Waterbury, manufactures over 150 different varities of recorders for all commercial ranges of pressure, temperature and electrical current, voltage and power. Thousands of these instruments have been sold, and there is a constantly growing demand as their value is becoming better appreciated.

A New Telephone Company. The Kurtz National Telephone Company of the State of Indiana has been incorporated for $50,000, and the following officers elected: William H. Dye, president; J. V. Mitchell, secretary; John N. Cobb, treasurer; William J. Kurtz, vice-president and manager. This State company has a model plant in operation at Martinsville, Ind., and four towns connected up by toll lines, and is authorized to do business in every county in the state.

X-Ray Studio. Mr. Frank Martin, well known as an expert operator in the practical application of X-rays, is meeting with much success in his work. He was the first to make a business of applying X-rays, his studio at 110 East Twenty-sixth Street having been established in April, 1896, shortly after the first experiments with Prof. Röntgen's great discovery were made in this country. Mr. Martin also examines patients at their homes and acts as expert in legal cases.

Electrical Novelties. Devoted to the production of electrical novelties, the Ohio Electric Works, of Cleveland, are working night and day to meet the demand for their battery table lamp, necktie light, light, dollar motor and bicycle light. The head of the concern gives his personal supervision to every department, and the company has complete confidence in its ability to offer inducements which cannot fail to compel favorable consideration. The Ohio Electric Works desire agents everywhere to sell the four leading electric novelties above mentioned.

The Carbon Works of Julius Fuchs in Nuernberg is now controlled by Schiff, Jordan & Company, of Vienna, who inform us that Mr. Fuchs has manufactured the "Electra" carbons for a number of years, and will hereafter have charge of the manufacturing department of the Vienna Works, as well as of his Nuernberg plant. Mr. Fuchs has recently made great improvement in carbons for alternating current and for the enclosed-arc lamp. These carbons will be sold exclusively by Schiff, Jordan & Compnny, 232 Greenwich Street, New York.

Porcelain Fittings. The Peru Electric Manufacturing Company, of Peru, Ind., has recently patented and is placing upon the market, a multiple-tablet board for the three-wire system. This board is made of sectional pieces of porcelain and can be built for any number of circuits. A multiple-circuit board for two-wire system, somewhat similar to the above, is also manufactured. These boards, together with the same company's new line of branches and mains, and its new transformer fuse plug, are of general interest to electricians.

Mr. Hugo Reisinger, of No. 38 Beaver Street, sole agent of the celebrated "Electra" highest grade Nuernberg carbons, informs us that the outlook for the present season, is most promising. The large and numerous orders that have lately reached him, prove not only an increase in business, but that station managers are fully aware of the advantages gained by the use of the best carbons obtainable. The European factory Mr. Reisinger represents, has been enlarged recently, thus enabling him to fill orders for the largest quantities of carbons on short notice.

Enclosed-Arc Lamps. In an interview with Mr. F. E. Dolbier, manager of the arc lamp sales department of the General Incandescent Arc Light Company, Bowling Green Building, New York, he stated that the continued and increased success which they are meeting in the sale of their enclosed arc lamp is significant evidence of the satisfactory service obtained by the use of the same. He mentioned among others, that they had just closed a contract for the installation of the Bergmann enclosed arc lamp, in the new addition of Bloomingdale Bros., dry goods store in New York City.

Dry Batteries. Wm. Roche, 259 Greenwich Street, New York, has been making dry-battery cells for some of the well known supply dealers for many years, and in that time has produced several of the most popular dry cells now on the market. This experience Mr. Roche now proposes to use to his own advantage by establishing a business of his own, and has produced a new standard dry-battery cell of from 10 to 15 amperes capacity on short circuit, and from two to three years' life on ordinary open-circuit work. His aim will be to put out only the highest grade cells at a reasonable price.

Switches. In addition to its widely known New England switches, the O. S. Platt Manufacturing Company, of Bridgeport, Conn., has, within the past year, put upon the market, a single-pole and a double-pole push-button switch-knife switches that are thoroughly practical and reliable, meeting the 1897 rule of the National Board of Fire Underwriters' flush switches, 10- and 15-ampere sizes, with key or solid handle, and with or without indicator, showing the words "On" and "Off." The goods of this company are designed for service, utility and convenience, keeping in view the fact that low prices and the best goods are what the trade demands.

Fuel Economy. The Fuel Economizer Company, Matteawan, N. Y., has just completed erecting an economizer at the new station of the Edison Electric Illuminating Company, of Brooklyn. There are now in course of construction economizers for the new station of the United States Electric Lighting Company, Washington, D. C.; for the Brooklyn Heights Electric Railway Company; the Imperial Electric Light, Heat & Power Company, St. Louis, Mo.; the Merchants' Cotton Company, St. Henri, Montreal, Q e.; Lancaster Mills, Clinton, Mass.; Dutchess Hat Works, Tioronda, N. Y.; Chelsea Jute Mills, Brooklyn, N. Y., and S. Sanford & Sons, Amsterdam, N. Y.

Commutator Compound. Holm's Tesoline, made by the Boiler Expurgator Company, 115 Dearborn Street, Chicago, Ill., is rapidly becoming recognized as an indispensable article for the dynamo room. That its merits are not over-rated is evident from its adoption by concerns who only buy with discrimination, such as the Illinois Steel Company, Gates Iron Works, Illinois State Insane Asylum, Marshall Field & Company, the Woman's Temple, Chicago, and others too numerous to mention. The distributing agents for Holm's Tesoline are Bibber-White & Company, Boston, Mass., the Electric Appliance Company, Chicago, Ill., and the Southwick Oil & Grease Company, of San Francisco.

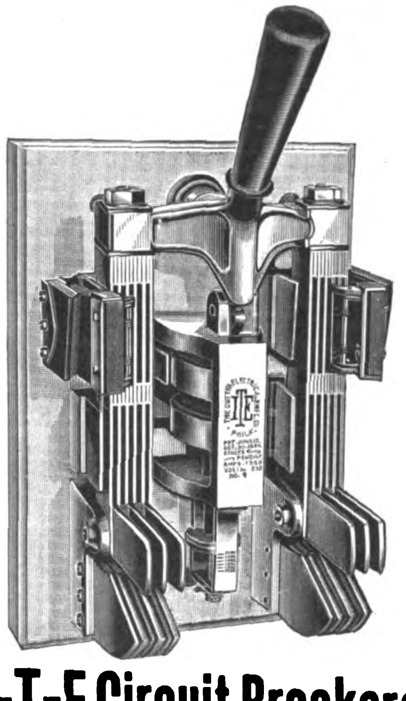
Water Power Governors. The Replogle Governer Works find the outlook for business in the line of water-wheel governors decidedly better than one year ago. There are more inquires, and manufacturing concerns that have had their water-power in use for years with little or no attempt at automatic regulation of speed, are beginning to see the desirability of putting their plants on a modern basis, and feel warranted at the business outlook to make the investment. The Replogle Governor Works call our attention to the interesting fact that in the illustration of thier governor in the article on "A Practical Application of Electric Heating," on page 463, of December issue, the hand wheel shows three different positions during the brief exposure of the photographic plate.

B. & O. Electric-Light Plant. In accordance with the policy of economy adopted by the receivers of the Baltimore & Ohio Railroad, an electric-lighting plant has been installed at Philadelphia for the purpose of lighting the passenger station, yards, freight stations, freight yards, docks, roundhouses, machine shops, etc. Twice as many lights are in service now as when the company purchased the current from local lighting companies, yet the expenses have been reduced one-half. The Philadelphia plant consists of one 150-HP boiler, two 50 G. E. arc-light generators, which are belted to a 125-HP standard Westinghouse engine. It took 20 miles of wire for the overhead construction, and a submarine cable is used in crossing the Schuylkill River.

Electrical Soldering Paste. The Highland electrical soldering paste is claimed by the Electric Appliance Company, Chicago, to be the only soldering flux to use where careful work is a requisite, and that careful comparative tests have shown that it gives the very best joint that can be made with the least possible amount of solder and without any corrosion whatever. It is now being used almost exclusively by telephone companies, with whom the foregoing points are particularly valuable. The electric-light companies are also coming to realize that it is very important that every joint made on their lines should be a good joint, and are now using the Highland paste very extensively.

THE PERFECT CLUTCH FOR T.-H. and Brush Lamps.

The Only Reliable Clutch
Guaranteed absolutely PERFECT in its action.
Used and endorsed by all the leading Central Stations throughout the country.
We also manufacture a superior line of
ARC CUT-OUTS and all
ARC LIGHTING SUPPLIES.
Our Goods are of the Highest Grade, our Prices are Low, and we can make Prompt Shipments.
THREE IMPORTANT THINGS TO CONSIDER WHEN BUYING.
The Philadelphia Elec. & Mfg. Co.,
OFFICE, No. 2011 MARKET STREET.
Factory, 2011 Market and 2010 Commerce Streets (formerly Jones Street).



I-T-E Circuit Breakers
are used exclusively in the American Lithographic Building, as described in the leading article in this issue.
The Cutter Electrical & Mfg. Co.,
PHILADELPHIA,
1112 Sansom Street.
NEW YORK OFFICE,
120 Liberty Street.

The Electric Appliance Company, Chicago, is sending out a small box at a nominal price, which gives an opportunity to test the paste and, besides, is a supply of paste which will last probably as long as one pound of soldering salt and do far better work.

The Weston Engine Company, is finding trade, so far as it is affected, far beyond expectations, in fact, being compelled to refuse orders for engines at the present time. Orders for something over 30 engines are booked, and arrangements are now being made for a large addition to its plant, to be erected as soon as weather will permit. A large night force of men is to be put on in order to take care of work in hand, in place of the small force at work at the present time. Only a few days ago telegraphic orders were received for two 125-HP engines, direct-connected type, to be used in lighting the municipal buildings in the City of Mexico. Three 175-HP engines, direct-connected type, are also being built for the new court house at Fort Wayne, Ind., and a number of other orders have been received for prominent buildings throughout the United States, and a large amount of possible work is in sight. The prospects for 1898 are very bright, and the Weston Company anticipates the best year in its history.

Gas Engines. The Lambert Gas Engine Company, of Anderson, Ind., reports business better than at any previous time in its history. Replying to an inquiry as to its present capacity, Mr. C. E. Hogle stated, "We started the year 1897 with the intention of building an engine a day. We have, however, more than doubled this output. The outlook for the coming year was never so bright, and it is our intention to increase our facilities in the immediate future, so that we may keep abreast of the demands made upon us." This company manufactures a specially designed engine for driving electrical apparatus, in which it guarantees a speed sufficiently uniform to develop current that will make light without any perceptible variation, direct belted without intermediate counter-shaft and balance wheels, or even a balance wheel on the armature of the dynamo. This company has recently issued a new catalogue of special importance to power users interested in gas engines.

Storage-Battery Contracts. The Electric Storage Battery Company, Drexel Building Philadelphia, has just closed a contract with the Chicago Edison Company for a storage-battery plant with a capacity of 7,436,800 watt-hours. This will be the largest battery installation ever made. The contract includes switch-board and all the auxiliary apparatus, and will be completed in March, 1898. This installation will be an object of great interest to the members of the National Electric Light Association at its next meeting which is to be held in Chicago in June. The Battery Company has also closed a very important contract with the Buffalo Railway Company. The battery is to be used in conjunction with power furnished by the Cataract Construction Company at Niagara, over its high-tension transmission lines to Buffalo. This is a most important development, and one which is being watched with intense interest all over the world. Both of the above batteries are the largest for their purpose that have ever been installed. The year's business done by the Electric Storage Battery Company shows a very remarkable increase over preceding years, and indications are that the coming year's business will far exceed the results of the present year.

The "Electra" Carbons. Mr Hugo Reisinger, No. 38 Beaver St., New York, desires us to make public the following notice concerning certain statements recently made in trade papers: "I wish to inform the trade that the word 'Electra' has been properly registered by me as my trade-mark and therefore, cannot be used by anybody else without infringing on my rights. The 'Electra' carbons are made, as heretofore, by the world renowned firm of C. Conradty, Nuernberg, who owns not only the oldest, but the most extensive carbon works in existence and whose carbons remain unequaled in quality and efficiency, having become the standard for electric lighting the world over. As to parties reported as makers of 'Electra' carbons, I wish to state that I have brought suit against them for having misused the trade-mark 'Electra' and that they have been enjoined by the Nuernberg courts from making any carbons stamped 'Electra' under penalty of 100 Mks. for each carbon. I shall guard the interest of buyers of my carbons as heretofore, and any information in regard to infringements on the registered trade-mark 'Electra' that will enable me to take legal proceedings, will oblige."

Fire Extinguisher for Electric Generating Stations. The Underwriters' Equipment Company, 2 Wall Street, New York, is soon to place on the market a new device for extinguishing fires which is

NATIONAL

Matte Smelter.

A PRACTICAL and simple method of matting sulphide ores. In localities where lead ores and fuels are scarce and almost unattainable, our pyritic, water-jacketed Matte Smelter has been recognized with highly satisfactory results, and has been thoroughly tested on various pyritic, sulphide and arsenide ores, in capacity of two to eighty tons per day. It is the most practical, cheapest and simplest method of gold and silver ore matting and concentrating that is known to-day.

It requires no extraordinary skill, no lead ores, no fluxing material, and no fuel of any kind for the smelter after it is started. The sulphur in the ore is its natural fuel only, and its cost has no comparison with any other process of concentrating.

We are prepared to furnish any size or capacity plant complete to substantial mining people, set it up and furnish our men to run it for them on easy payments. Prices and specifications furnished with references and testimonials on application.

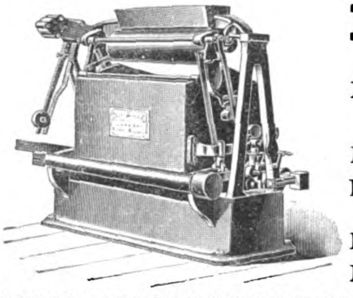
The National Ore & Reduction Co.

415 Locust Street,

ST. LOUIS, MO.

Manufacturers of Furnaces for

Nickel, Copper, Gold, Silver and Lead Ores.



HIGH CLASS MACHINE TOOLS

for Machine Shops and General Metal Finishing Use.

Machines, Fixtures, Small Tools and Gauges for the manufacture on the interchangeable plan of Guns, Sewing Machines, Typewriters, Cash Registers, Bicycle Parts, etc.

Brass Finishing Machinery.

Reliable Counting Registers, Standard Measuring and Testing Machines.

Drop Forging Machinery: United States Standard Threading Machines and appliances.

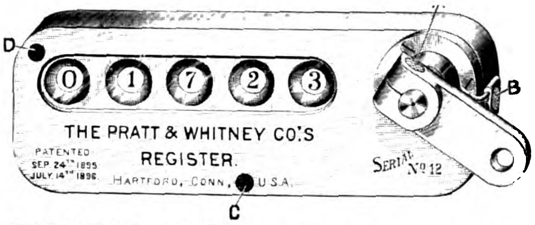
Milling Cutters, Combination Lathe Chucks.

AUTOMATIC WEIGHING MACHINES for accurately weighing coal and all material of a uniform size handled for storage and distribution.

Lathes, Planers, Shapers, Drilling and Milling Machines for Tool Room use.

Bar Iron Limit Gauges, useful to protect the buyer of bolt iron against the delivery of material of sizes unsuitable for use without changing dies for heading or threading and of excessive weight.

Brigg's Standard Pipe Thread Gauges, useful for testing pipe and fittings to insure their delivery in condition for connection without rethreading when ordered to said gauges.



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CHICAGO: 42 So. Clinton St.
BOSTON: 144 Pearl Street,
NEW YORK: 123 Liberty St.

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London, England,
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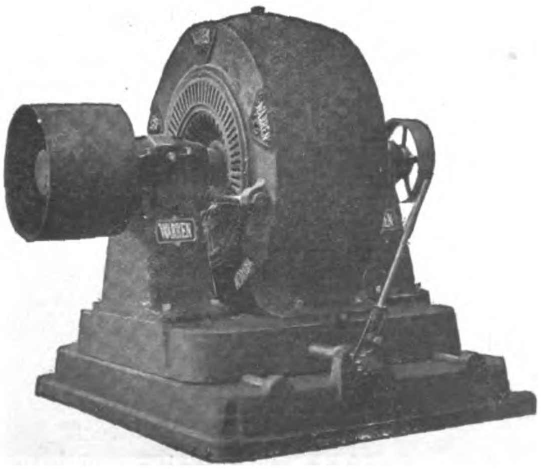

WARREN ALTERNATOR

SCHEEFFER WATTMETERS
SCHEEFFER TRANSFORMERS
PARAGON ARC LAMPS

Complete Alternating Current Equipments.

H. B. COHO & CO.

Broadway and Ann Street,

ST. PAUL BUILDING, NEW YORK.

EDDY DYNAMOS
EDDY MOTORS
CROWN BRUSHES

praticularly applicable to electrical plants, where the use of water for this purpose is apt to increase danger through establishing short circuits. It resembles, in appearance, the familiar portable chemical fire extinguisher. In fact, it is a chemical extinguisher itself, with an additional chamber, which acts as a reservoir for the carbonic acid gas generated by the combination of a saturated solution of bi-carbonate of soda with sulphuric acid. The dry gas is forced out through a suitable nozzle by its own pressure and directly applied to the flames, which are immediately extinguished. The design and construction of the gas extinguisher are remarkably simple, and its operation and control are equally simple. By an ingenious check valve used in mixing the two fluids, all danger from explosion is avoided. The apparatus has been practically tested, and found to work with satisfactory results. The gas, as it is ejected from the nozzle, is perfectly dry, and has no damaging effect on the material to which it may be applied.

Forty Years of Light. The firm of I. P. Frink, 551 Pearl Street, New York, has for forty consecutive years jealously guarded its reputation for fair dealing, and the superior quality and construction of its reflectors. Successful from the start, it kept far in the lead, keeping pace with this age of light, improving quality and construction, so that the 1897 could hardly be recognized as a distant relative of the 1857 reflector. During this time it has lighted over 20,000 churches, covering nearly every country in the world, and thousands of halls, theatres, armories, schools, hospitals, court-houses, stores and public buildings, receiving the first prize, medal and diploma at the World's Fair, Chicago, 1893. Although advertising "The Great Church Light" extensively, it does not confine its efforts to churches only, but has lighted a number of the finest private mansions in the principal cities of America, recently lighting a reception room in New York, in which over $100,000 was expended on the interior decorations, $4000 of which was for the Frink reflectors for lighting the room. The reflectors were heavily plated with gold. The new Corcoran Gallery of Art, Washington, D. C.; the Rhode Island School of Design, Providence, R. I.; and Brooklyn Institute of Arts and Sciences, and Hart Memorial Library, of Troy, N. Y., have recently been lighted by it, and it has now on hand good orders from Africa, China, England and France, and from churches in nearly every state in the Union, which goes to show the wide-spread popularity of the Frink reflector. During the holidays, it frequently receives orders by telegraph, giving size of room to be lighted, with no previous correspondence. These few straws clearly indicate the esteem in which the firm is held by the general public. Its facilities for turning out good work promptly are more perfect than ever before.

Recent Westinghouse Contracts. The factory of the Westinghouse Electric & Manufacturing Company, at East Pittsburgh, Pa., is at the present time very busy on a number of electrical machines all intended for Niagara Falls and other companies in the vicinity of the great electric power center. It will be remembered that about six months ago, the Cataract Coustruction Company contracted with the Westiughouse people for an enormous addition to the power station, consisting of five 5000-HP generators, of the same pattern as the three already installed. In addition to these five machines, which are now under way—in fact shipment has already commenced—the factory is also building exciters, representing a capacity of 675 HP. The switch-board with necessary appliances controlling the five 5000-HP generators is also being made now, and all of these machines will be applied to the Niagara power house as soon as required. The Niagara Falls Hydraulic Power & Manufacturing Company some time ago contracted with the Westinghouse Company for six 750-HP direct current generators, 300 volts, 250 r. p. m. These generators will be direct-connected to Leffell turbines, and they will be used for generating current, that will be supplied to the Aluminum factory of the Pittsburgh Reduction Company, at Niagara. The Westinghouse Company has also constructed two 300-HP, two-phase induction motors, contracted for by the Buffalo, Niagara Falls Electric Light & Power Company. These motors will be used for alternating-current generators, direct-current generators, arc machines, etc. The Niagara Electro Chemical Company has contracted for a large increase in its transformer station, located above the power house of the Niagara Falls Power Company,

GENERAL
ELECTRIC
COMPANY,

SCHENECTADY, N. Y.

The LARGEST ELECTRICAL MANUFACTURING COMPANY in the WORLD, and the only one which manufactures every electrical device necessary for

ELECTRIC
LIGHTING,
MOTOR POWER,
RAILWAYS,
MINING
AND
LONG DISTANCE
POWER
TRANSMISSION.

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For all business outside the United States and Canada:

Foreign Dept., Schenectady, N. Y., and 44 Broad Street, N. Y.

For Canada, address Canadian General Electric Co., Ltd., Toronto, Canada.

The name of
WESTINGHOUSE
is a guarantee.

Westinghouse Electric
Invent, make and sell electric apparatus. We do so, despite the keenest competition. ❧ ❧ ❧ ❧

Westinghouse Electric
Workshops are largest and best equipped in the world, and the inventions manufactured here, make our output the electrical standard of the world.

Westinghouse Electric
Rivals devote much time and energy to denunciations of our apparatus. That is to be expected. But we say nothing about their products or their methods. We do our own business in cur own way. ❧ ❧ ❧ ❧ ❧

Westinghouse Electric
Work speaks for itself. Our motors, whether for railways or mills, are never supplanted. ❧

Westinghouse Electric
Meters— Shallenberger, renowned for accuracy. Lightning Arresters— Wurts—we give the real name of the real inventor —the only sure protectors for electric plant. We make everything electric. ❧ ❧ ❧ ❧ ❧ ❧

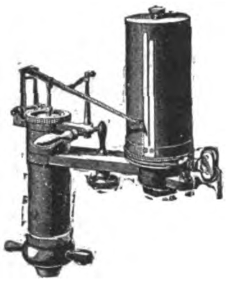
Westinghouse
Electric & Mfg. Co.
Pittsburgh, Pa.

New York, Boston, Chicago, Philadelphia,
San Francisco, Buffalo, Syracuse,
St. Louis, Atlanta, Tacoma.
Ahearn & Soper, Ottawa.

Westinghouse Electric Co., Ltd.
32 Victoria St. London.

The name
WESTINGHOUSE
is a guarantee.

consisting of three 235-HP, two-phase rotary transformers and one 175-KW rotary transformer supplying current for the reduction of metallic sodium from caustic soda. In addition to these transformers, the Westinghouse Company is also making for the same company, 800-HP in air-cooled oil converters, consisting of six 133-HP converters, 3000 alternations, which will supply current for the rotaries. The Acetylene Light & Power Company has contracted for two 1000-HP oil converters, water-cooled, of 3000 alternations, primary 2200 volts, secondary 100 volts. These converters will supply current for arc furnaces for the manufacture of calcium carbide. The Mathieson Alkali Company contracted with the Westinghouse Company some time ago for a number of rotary transformers, induction motors and oil converters, which were recently installed, and consist of eleven 165-HP rotary transformers, several small induction motors, twenty-two 82½-HP oil converters, four 33½-HP oil converters and two 13½-HP oil converters. These facts are the best evidence of the growing activity manifesting itself in the use of electrical apparatus at Niagara Falls, all of which has been occasioned by the erection of the large power station of the Cataract Construction Company, the generators for which were installed by the Westinghouse Company.



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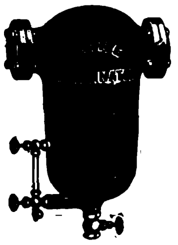

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The HANDSOMEST PACK OF CARDS ever printed.

SEND 2-5 lb. or 1-10 lb. label from front of EUREKA PACKING box for pack of cards.

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AMERICAN FEED WATER HEATER heats water hotter with Exhaust Steam and is lower in price than any other. 10 years' guarantee.

Improved Robertson-Thompson Planimeters, Reducing Wheels, 3 Way and Elbow Cocks, Shaking Grate Bars, Waste Oil Filters, Exhaust Heads. | Jas. L. Robertson & Sons, 204 FULTON ST., N. Y. 12 Pearl St., BOSTON.

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We are the Largest Manufacturers in the United States of

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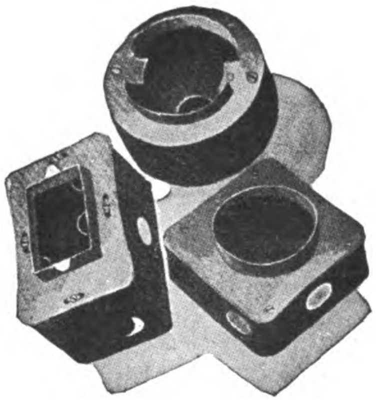
Over 800 Styles and Sizes of Switches. Don't Buy Cheap Goods. Write for Prices.

Our Switchboards are in some of the Best Buildings in America. SEE THAT YOU GET HILL SWITCHES.



Standard Steel Armored, Slate Lined, Self Contained

Panel and Distributing Boxes

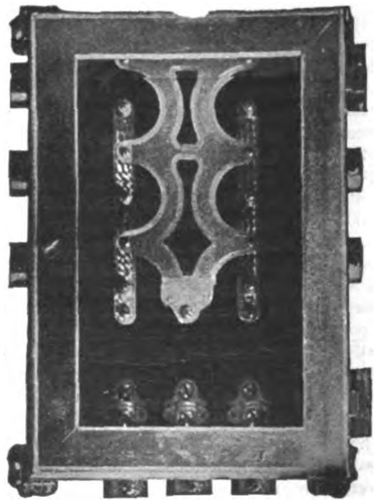
For any number of Circuits, with or without Switches, two or three wire system.

MAIN FEEDER AND TERMINAL BOXES,

For buildings, marine or underground work.

Steel Drawn Switch, Wall and Ceiling Outlet Boxes, threaded for Conduit and provided with Water-tight Cover,

For either brass or iron armored conduit, switches and switchboards.



The Bossert Electric Construction Company,

UTICA, N. Y.

THE ONLY WATER-WHEEL GOVERNOR THAT GOVERNS.

WATERVILLE AND FAIRFIELD RAILWAY AND LIGHT CO.,
Waterville, Me., January 18, 1896.

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Gentlemen: In regard to your Type C Governor, which is regulating for us our two Hercules Wheels which give power to operate our light plant, street railroad and power generator, we are frank to admit that THE MACHINE DOES ITS WORK ADMIRABLY. We have no hesitancy in recommending it to those in want of a Governor.

Yours truly,
(Signed) I. C. LIBBY,
President Waterville and Fairfield Railway and Light Co.

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A VALUABLE BOOK.

Power Distribution for Electric Railroads

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WANTED—A man competent to fill the position of general manager of a small alternating central station, in a town of 10,000 inhabitants. None but those having had experience need apply.

Address "MANAGER,"
care AMERICAN ELECTRICIAN, New York.

WANTED—Copies of the AMERICAN ELECTRICIAN for January, February, March, August and September, 1897. Subscribers having clean copies of these issues will have their subscriptions extended two months for each copy of January, February and March, and one month for each copy of August and September, sent us postpaid.

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FULL-SIZE WORKING DRAWINGS of a 10 volt, 10 ampere Volt-Ammeter, with complete instructions for making. Price, one dollar.

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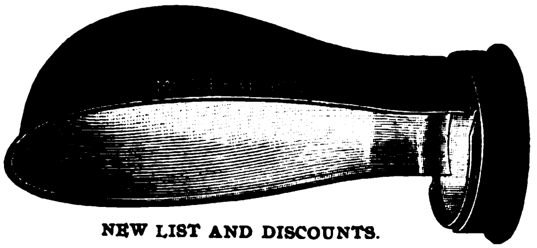

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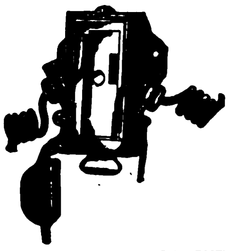

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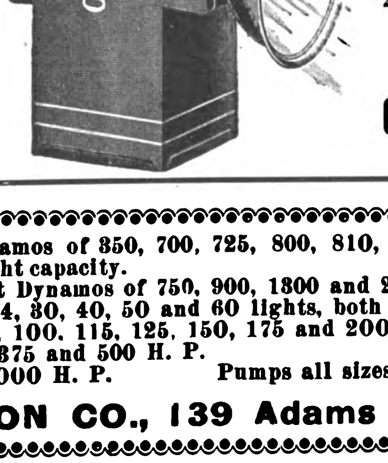

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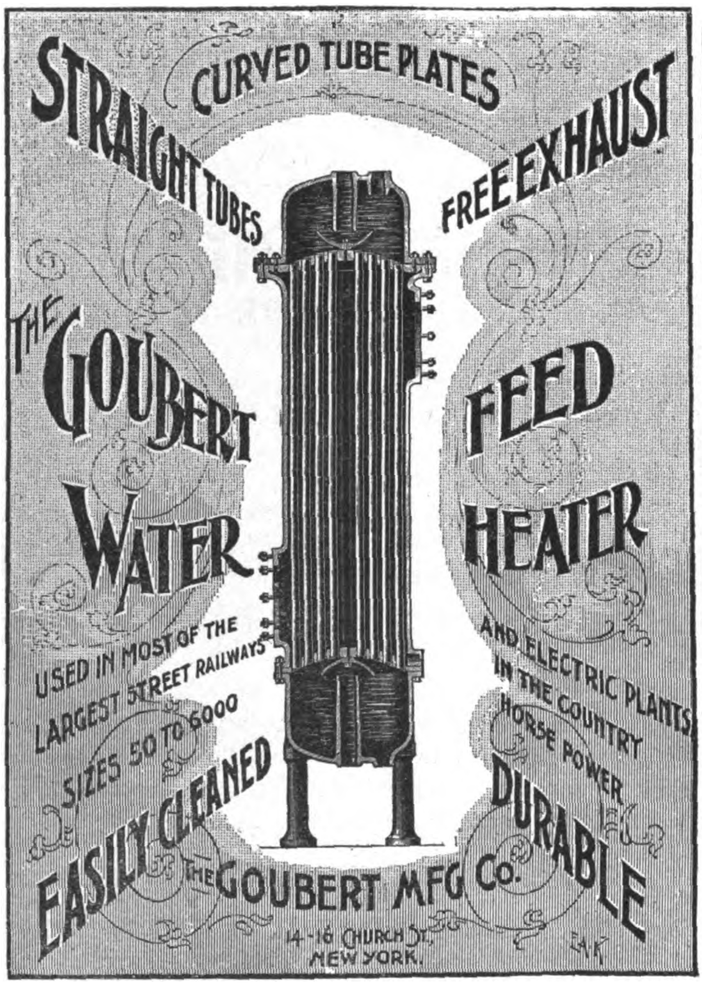
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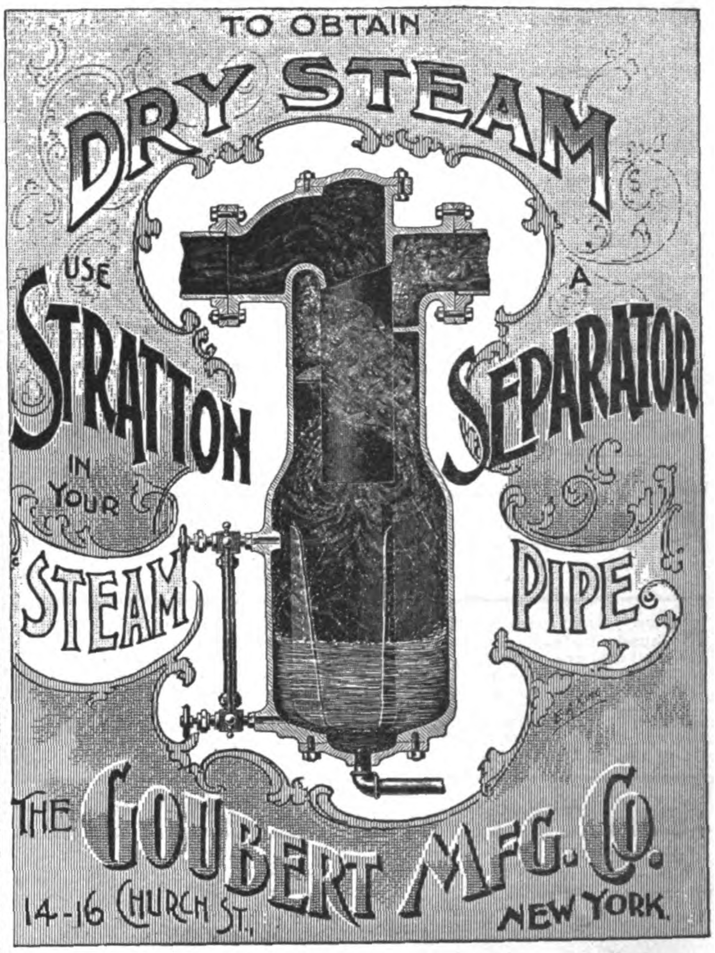
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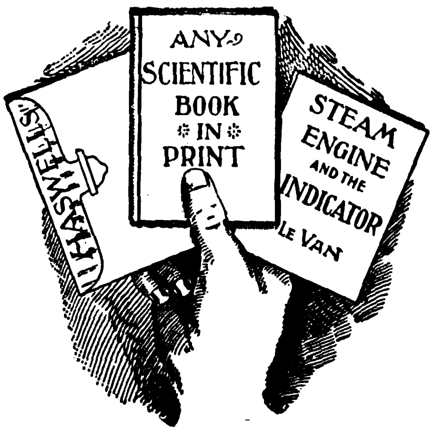
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American Electrician.

Vol. X. New York, February, 1898. No. 2.

BUTTE, MONTANA, ELECTRIC POWER TRANSMISSION PLANT.

THE MONTANA POWER COMPANY.

BY L. D. TANDY.

The Montana Power Company, which was organized Aug. 10, 1897, will have, when ready for practical operation, a plant that will rank among the finest in the United States, not only from an engineering but from a financial standpoint. The plant was projected, financed and built upon a different basis from any other of a similar character in the country, the entire proposed output having been contracted for before ground was broken. Thus the problematical feature as to the income to be derived from the en-

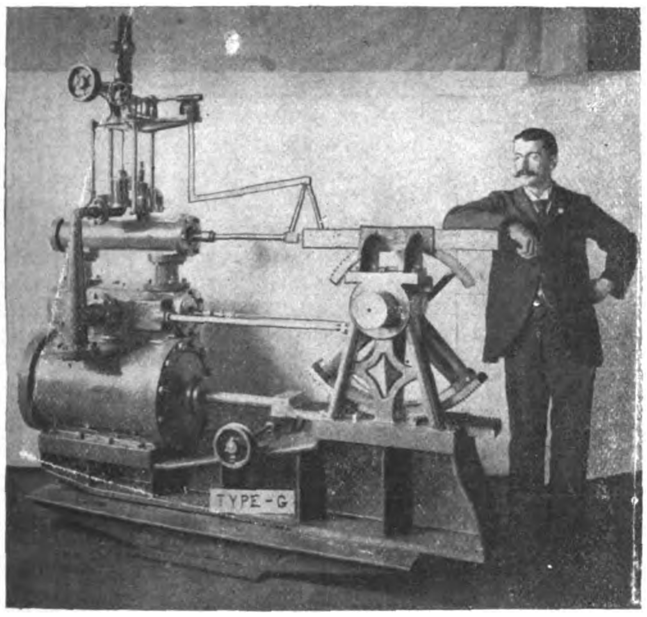


FIG. 1.—WATER WHEEL GOVERNOR.

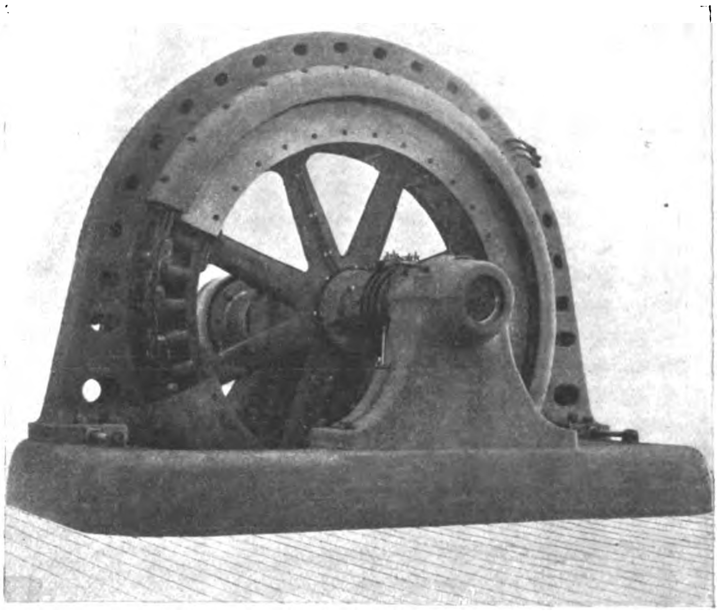


FIG. 2.—750 K. W. GENERATOR.

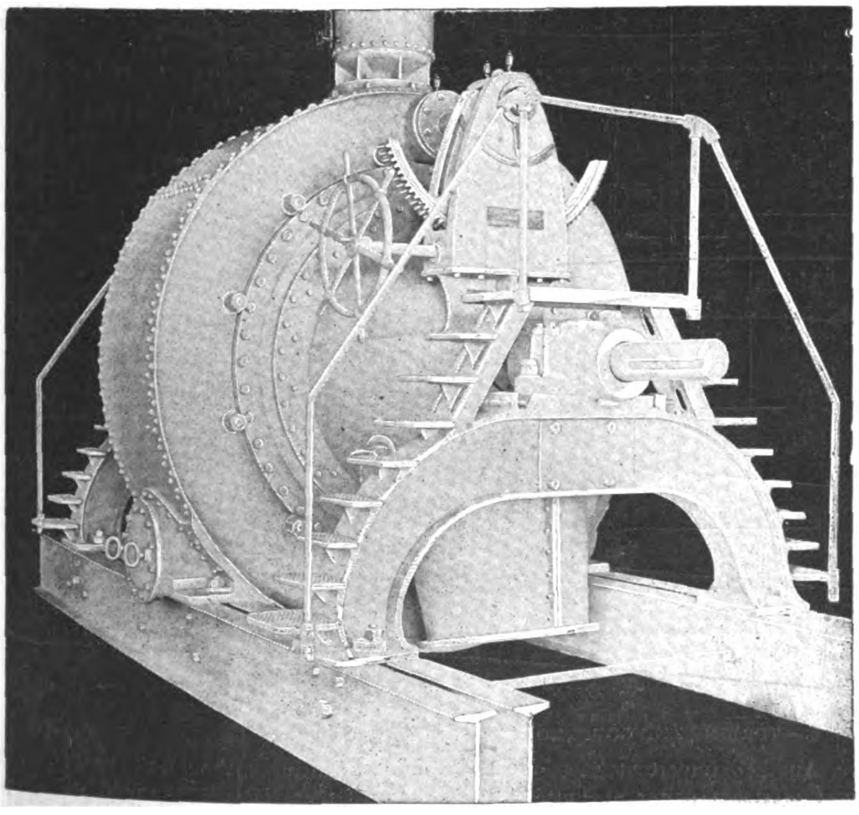


FIG. 3.—TYPE OF TURBINES.

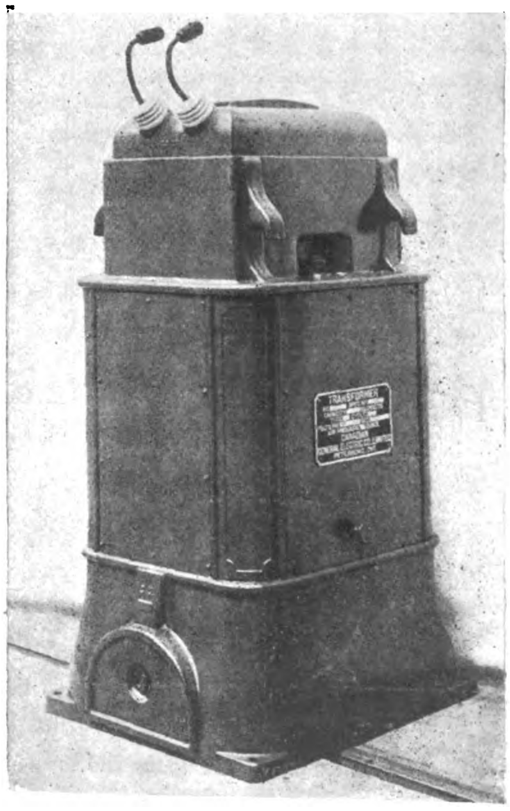


FIG. 4.—250 K. W. TRANSFORMER.

GENERATING MACHINERY AND TRANSFORMER.

terprise, was eliminated. The disposition of the power was made on a basis of five to ten year contracts, and at remarkably good prices for both the Power Company and the customers.

The coal used in the city of Butte is bituminous, from mines at Rock Springs, Wyo. Its high price ($3.60 per ton) and poor quality constitute one reason why its use for the generation of steam power is expensive. Another important factor in the high cost of steam power at Butte is the scarcity of water. The only way in which water can be obtained for condensing is from the city mains, and its cost, under such conditions, is, of course, prohibitive. It is consequently necessary to run all steam plants non-condensing, although the load factor of many of them is such as would make condensing a great source of economy.

The promoters of this company in drawing

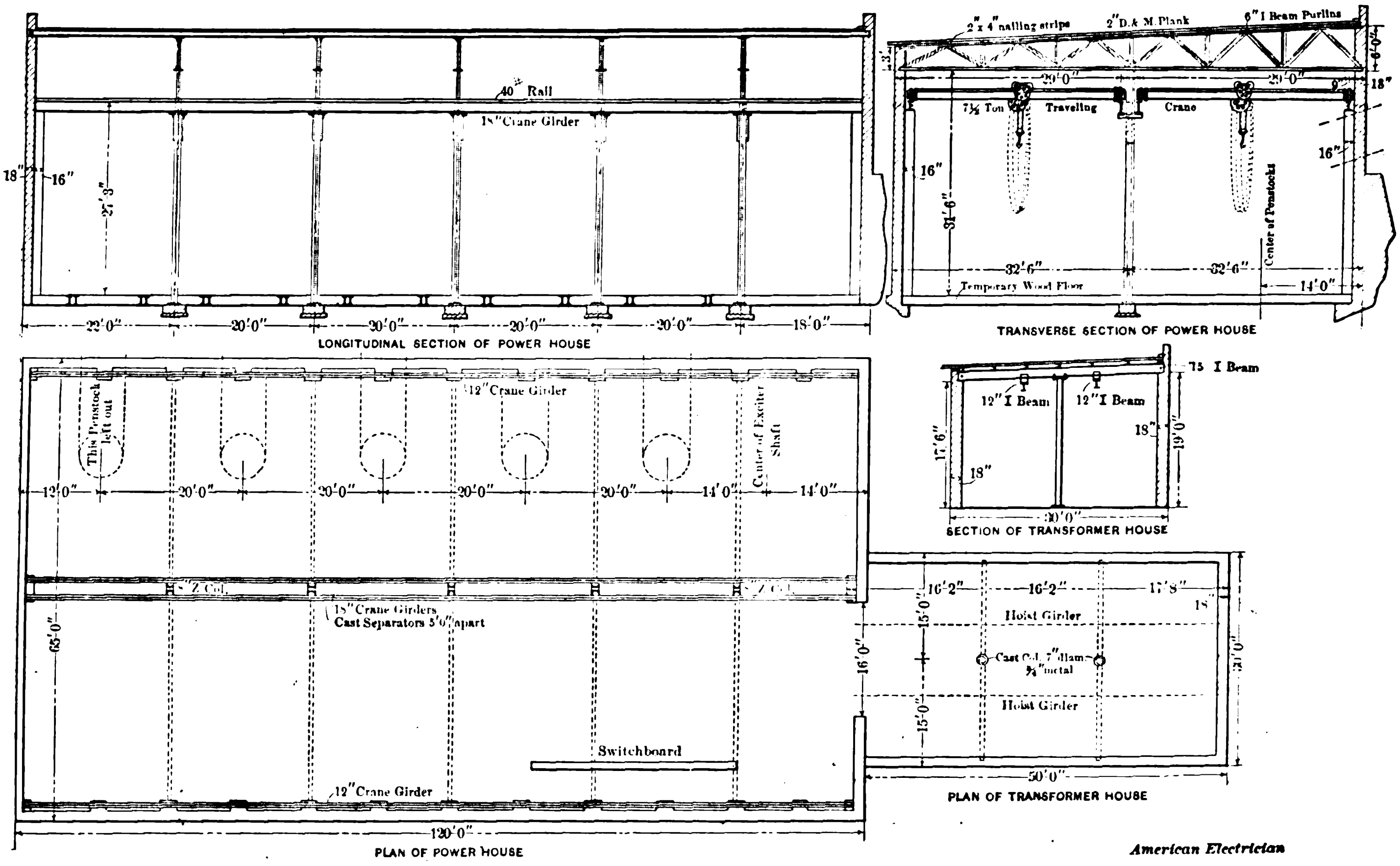

LONGITUDINAL SECTION OF POWER HOUSE
40# Rail
18" Crane Girder
18"
16"
27'3"
22'0"
20'0"
20'0"
20'0"
20'0"
18'0"
TRANSVERSE SECTION OF POWER HOUSE
2"x4" nailing strips
2" D.& M. Plank
6" I Beam Purlins
7½ Ton Traveling Crane
29'0"
29'0"
18"
16"
16"
31'6"
32'6"
32'6"
14'0"
Temporary Wood Floor
Center of Penstocks
SECTION OF TRANSFORMER HOUSE
15 I Beam
12" I Beam
12" I Beam
18"
18"
17'6"
19'0"
30'0"
PLAN OF POWER HOUSE
This Penstock left out
12" Crane Girder
Center of Exciter Shaft
12'0"
20'0"
20'0"
20'0"
20'0"
14'0"
14'0"
Z Col.
Z Col.
18" Crane Girders, Cast Separators 5'0" apart
65'0"
16'0"
Switchboard
12" Crane Girder
120'0"
PLAN OF TRANSFORMER HOUSE
16'2"
16'2"
17'8"
18"
Hoist Girder
Cast Col. 7" diam. ¾" metal
Hoist Girder
15'0"
15'0"
31'0"
50'0"
American Electrician

FIG. 5.—PLAN AND ELEVATIONS OF POWER HOUSE.

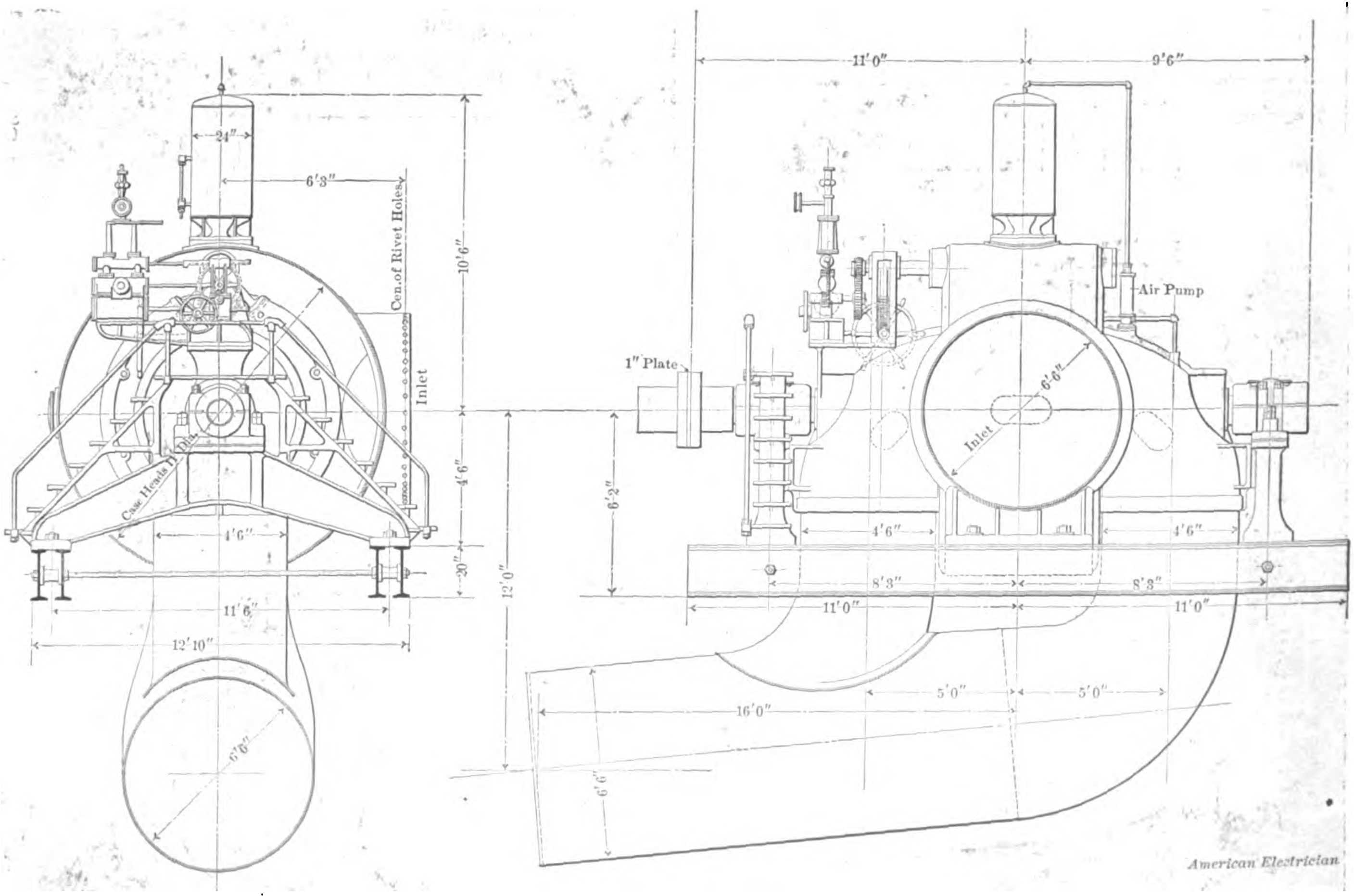

24"
6'3"
10'6"
Cen. of Rivet Holes
Inlet
Case Heads Tight
4'6"
4'6"
20"
12'0"
11'6"
12'10"
6'6"
11'0"
9'6"
Air Pump
1" Plate
6'6"
Inlet
6'2"
4'6"
4'6"
8'3"
8'3"
11'0"
11'0"
5'0"
5'0"
16'0"
6'6"
American Electrician

FIG. 6.—TURBINE AND GOVERNOR.

up the preliminary plans, decided to employ only the best material and apparatus obtainable, without any of the embellishments, ornamental rather than useful, frequently included in projects of this character. The first step was to secure the best available engineering advice, and J. T. Fanning, of Minneapolis, Minn., and M. S. Parker, of Great Falls, Mont., were chosen. A careful investigation was then made of the various types and manufactures of apparatus suitable to work of this kind, with a view to the selection of the best hydraulic and electrical machinery that the present market affords.

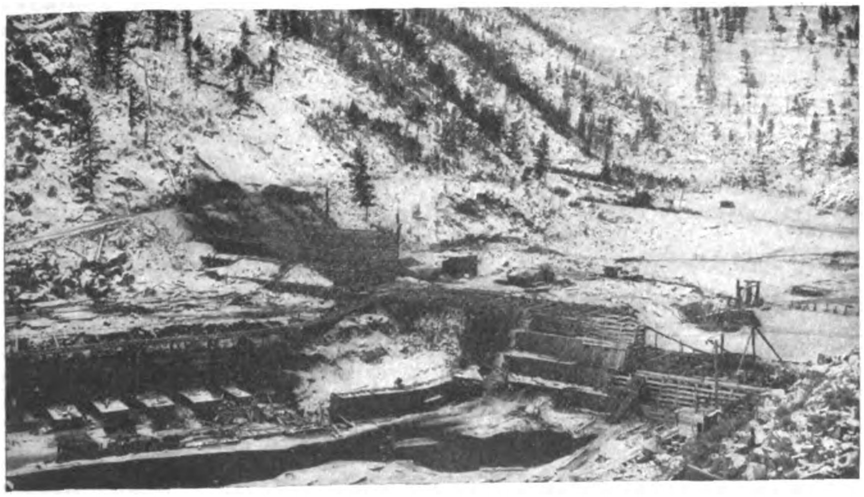


FIG. 7.—DAM, LOOKING DOWN STREAM.

Location.—The power station is located on the Big Hole River, 20.6 miles distant from the city of Butte, Mont. This distance is the total length of the transmission line, which is run in practically an air line from the power station to Butte.

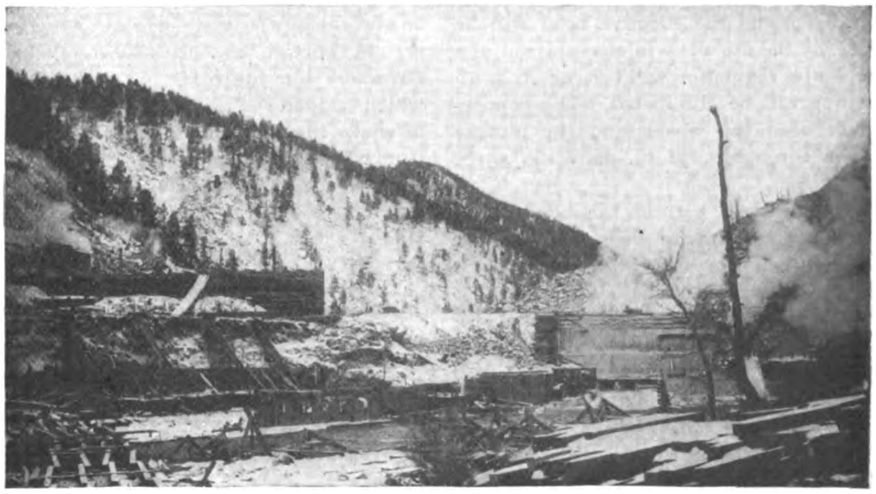


FIG. 8.—DAM, LOOKING UP STREAM.

Water Rights.—The water rights of the company are broad and cover three storage reservoirs above the main dam, as well as a location for an additional power station about 2 miles below the present one. Should it be found necessary, the capacity of the existing plant may be increased by building a second station on the latter site, utilizing the tail water of the present plant by carrying it through an open flume or pipe.

In California, where the laws for the protection of irrigation interests require that the normal flow of the stream be sustained, flood water only can be reserved, or stored. The storage of water in Montana, however, is not restrained by legislation, and when loads are light, water can be stored for use when heavy demands for power are made on the station. The lowest flow in the Big Hole River ever observed was 20,000 miner's inches, and that after a phenomenally dry season.

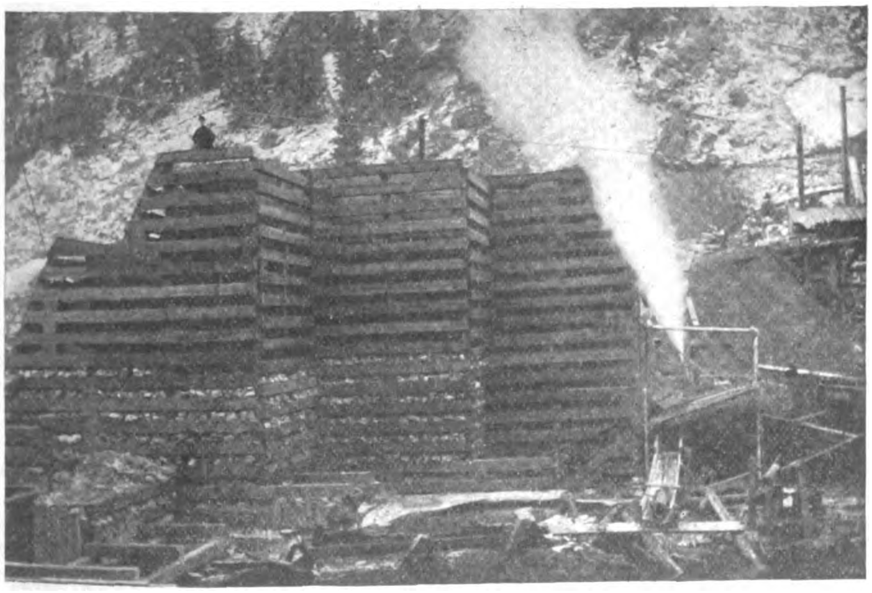


FIG. 9.—SHOWING CRIB CONSTRUCTION.

Dam.—The main dam (Figs. 7, 8 and 9) is a crib, the largest of its kind in the country, being 102 ft. wide at the base and 57 ft. high at the spillway. The total length at the crest is 450 ft., the spillway alone being 200 ft. wide. On the power station side, the dam will rise to a height of 12 ft. above the spillway. 10 in. × 12 in. Montana pine and fir timber in 12 and 16 ft. lengths, held together by 42 in. drift bolts, is used in the construction of the crib. (Fig. 9.) The foundations rest upon bed rock, and the crib is filled with concrete to a point 8 feet above the bed of the river, the remainder of the crib being filled with broken granite.

Two storage dams have been built, one 25 and one 28 miles up the river from the main dam, and a site has also been located for a third. These dams are 30 and 40 ft. high, respectively, and are built on the same general plans as the main dam.

The storage dams and the main dam will impound 2,100,000,000 cu. ft. of water. This will secure an ample reserve for heavy demands during exceedingly dry seasons.

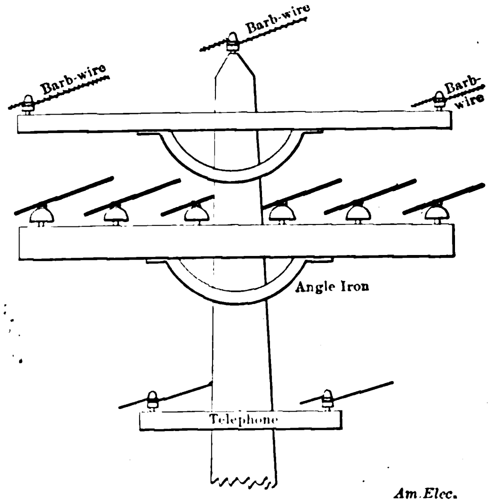


FIG. 10.—TRANSMISSION POLE.

Power Station.—The station, which is not yet completed, will be strictly fireproof and built of granite and concrete. The main

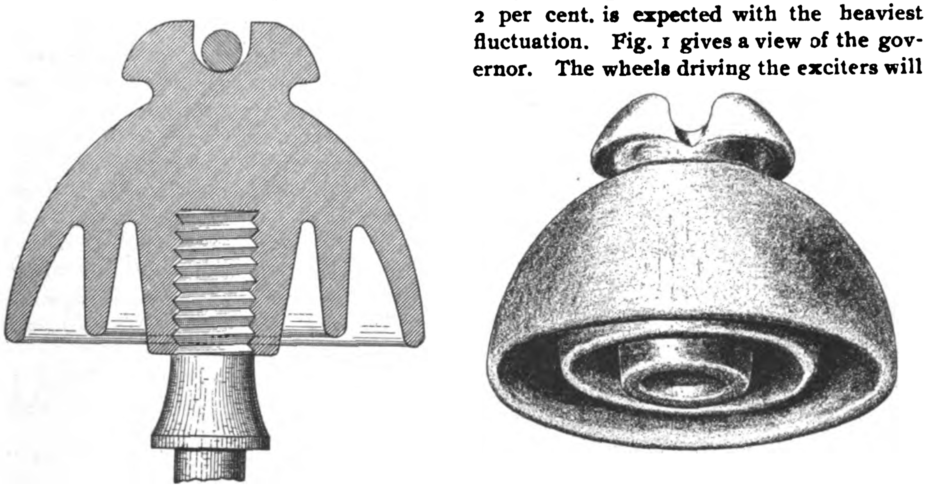


FIG. 11.—HIGH VOLTAGE INSULATORS.

building is located on the south side of the river, adjacent to the dam. Its ground dimensions are 125 × 78 ft., and the transformer room is 50 ft. × 30 ft. (Fig. 5.) The water will be supplied to the wheels from a forebay in the rear of the station. This forebay is 350 ft. long, 15 ft. wide and 23 ft. deep, and the effective head will be 60 ft. By the use of a forebay instead of a pipe, better regulation will be secured, as all ramming will be eliminated. The connection between the wheels and the forebay will be through a 72 in. penstock, 55 ft. long.

All foundations, both for the water wheels and generators, are on bed rock, and the space between them under the floors will be utilized as a cable tunnel. The roof will be of latticed steel girder, the contract for this and all the other iron work used having been placed with the Gillette, Herzog Company, of Minneapolis, Minn. Three traveling cranes will be installed, two of 16 tons capacity each, running the full length of the main building, and one of 5 tons capacity in the transformer section. These cranes will be furnished complete by the same company.

The building is exceptionally spacious, and is designed to receive five 1000 h. p. units, space being provided for an engine to be coupled to the fifth unit. Neither the fifth unit nor the engine, however, will be installed at present. This engine is designed for use only in times of excessively heavy loads, or when the water supply is abnormally low.

Water Wheels.—The James Leffel Company will furnish the water wheels for both the generators and exciters. There will be four 66 in. double turbines of the type shown in Fig. 3, directly coupled to the generators and developing 1200 h. p. at an effective head of 60 ft. while running at 180 r. p. m. These wheels are commonly known as the Niagara type and are of the same general design as those which have been installed for the Hydraulic Power & Manufacturing Company, of Niagara—the Cliff plant. Fig. 6 shows the details of the wheel and governor construction. The drawings from which the above cut was made have since been slightly changed, in that the intake will be from above the wheel where the air chamber is shown, instead of at the side. Two 36 in. single wheels will be *directly coupled* to the exciters.

Governors.—The Lombard water wheel governor will be used, one on each of the generator wheels. From the results obtained with this governor on the Leffel wheels at Niagara, a regulation somewhat better than 2 per cent. is expected with the heaviest fluctuation. Fig. 1 gives a view of the governor. The wheels driving the exciters will be governed by a simple mechanical governor. A special feature of the Lombard governors for this plant is that the water which actuates the primary cylinder is filtered, thereby eliminating any trouble from clogging of the cylinder or parts by sediment in the water. Otherwise they differ in only one important detail from the standard types of governors built by the same company, there being no pumping system connected with these governors, the circulating system being filled with water under flume pressure instead of oil under tank pressure.

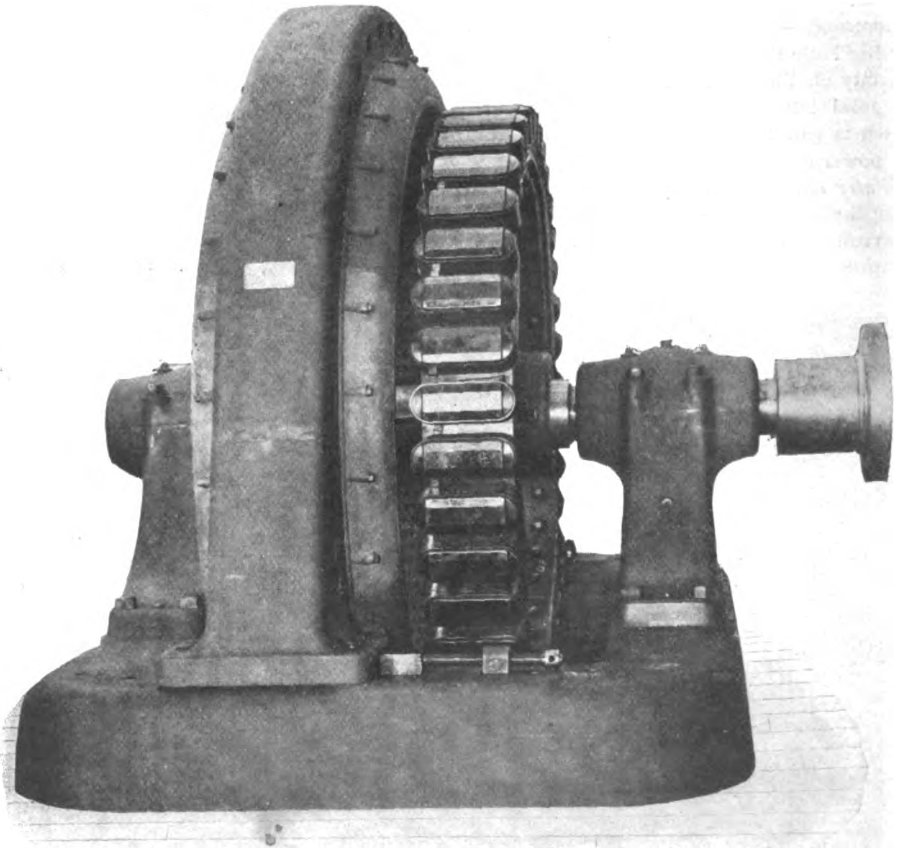


FIG. 12.—750-K THREE-PHASE GENERATOR, SHOWING ARMATURE WITHDRAWN.

In this particular plant the governor builders have specially designed the bed, ratio of gearing and connections in such a manner that the design is integral with the water wheels, of which the governors really become a part, as may be seen from the outline drawing, Fig. 6. These governors not only regulate the speed of the whole plant, but also start and stop the plant without manual effort. There are four units like the one shown in the illustrations.

Electric Equipment.—The entire electric equipment, both of the power company and of the companies utilizing the power, will be furnished by the General Electric Company, and will consist of four three-phase generators, of a capacity of 1000 h. p. each at their rated load. The generators are revolving field machines having forty poles, and a speed of 180 r. p. m., which gives a periodicity of sixty cycles. The current will be generated at a potential of 800 volts. The generators are practically the same in construction as other machines of the same company built to meet similar conditions, varying only in the number of poles and the speed. The revolving field will be 10 ft. in diameter over all and will weigh 23,500 lbs. A good idea of the general design of the generators can be had from Figs. 2 and 12. All the mechanical construction in these machines is based on a safety factor of twenty, ensuring absolute safety, even in case of a runaway at the full spouting velocity of the water.

There will be two exciters of the multipolar type, having each a capacity of 100 k. w. at rated load, and one exciter can furnish sufficient current to excite the five 1000-h. p. generators. They will be entirely independent in their operation, being directly connected to individual water wheels running at 600 r. p.m., and will operate at a potential of 125 volts.

The step-up transformers will be of the air blast type, 12 in number and of 250 k. w. capacity each, and connected in delta. (Fig. 4). The current will be delivered to the low tension side at 800 volts and increased to 15,000 volts for transmission.

In the substation in Butte 2640 k. w. capacity in step-down transformers will be installed of the same design as those in the main station, but of units of various sizes best adapted to the several uses for which they are to be employed. The high tension side of these transformers is wound for 13,250 volts, and the low tension side for 2,200 volts.

Both the main station and substation will be provided with two electric blower sets for circulating the air through the transformers.

The switchboard will be made of blue Vermont marble and consist of 15 panels, divided as follows :

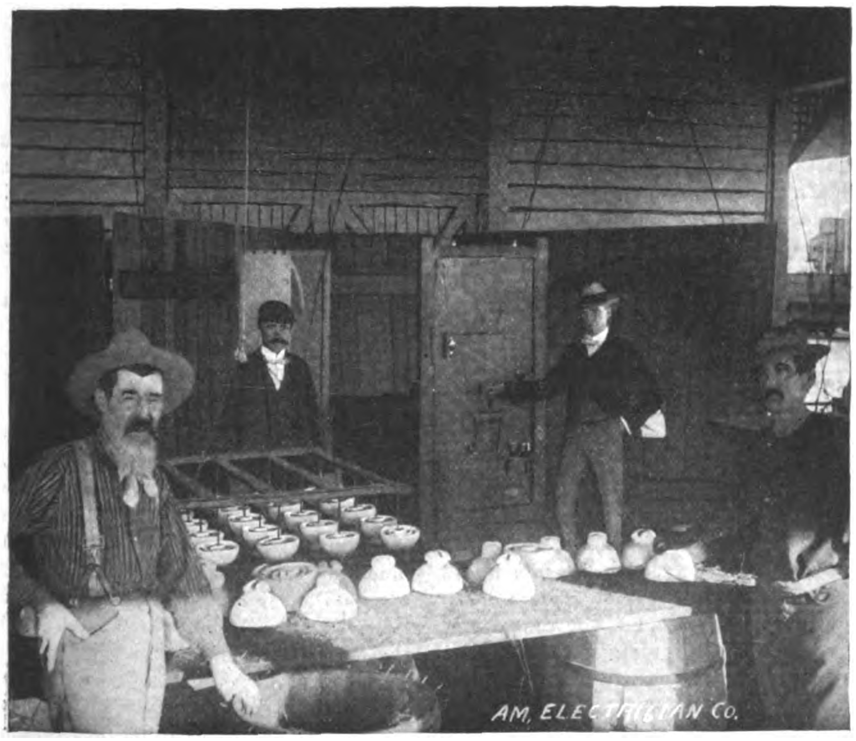

AM, ELECTRICIAN Co.

FIG. 13.—METHOD OF TESTING HIGH-VOLTAGE INSULATORS.

4 generator panels, 1 main station panel, 1 paralleling panel, 4 high tension transformer panels, 1 exciter panel, 2 line panels, and 2 low tension transformer panels.

The high tension portion of the main station switchboard will be located in the transformer building in a position where the attendant at the main switchboard can see it at all times.

The panels will be equipped with all of the latest improved instruments, and the station protected with General Electric lightning arresters. All generator and low tension transformer leads will be carried under the floor between the generator foundations, and will be accessible at all times for inspection, as there is ample room for a man to walk through the entire length.

Transmission Line.—The transmission line will be 20.6 miles long. The poles will be of Oregon fir varying in length from 33 ft. to 60 ft., with a minimum diameter of 12 ins. at the top, the average length being 40 ft. They are set 105 ft. apart or fifty poles to the mile, and have three cross arms, two 10 ft. 6 ins. in length, and one 3 ft. in length. The two upper or long cross arms are provided with a curved angle iron brace bolted to the pole and to the under side cf the cross arms. On the top of the pole and on the ends of the upper cross arm are glass pony insulators on which barbed wire is strung for lightning protection. Glass insulators are used for this purpose to prevent friction and consequent breaking, as is usually the case when the barbed wire is attached by staples. The upper arm is used exclusively for this barbed wire line.

The second or middle arm is provided with six pins to accommodate two three-wire circuits. The lower or short arm is for a private telephone line.

The insulators (Fig. 11) were furnished by the Imperial Porcelain Works, of Trenton, and are of the "Redlands" type. They have all been subjected to a test of 70,000 volts before and after glazing. The weight of each insulator is 5½ lbs., the diameter 6¾ ins., and the height 4⅞ ins. The surface distance from the tie wire to the pin is 13 ins.

A method for testing high voltage transmitters is shown in Fig. 13. The source of E. M. F. is a slot wound alternator. The insulators to be tested are partly immersed in water, one pole of the alternator being connected to the body of water. The other pole of the alternator is connected to a frame work in which are as many vertically downward projecting pins as there are insulators to be tested. The insultator pin hole is filled with water and the frame lowered until the pins in it are almost in contact with the water. Upon the circuit being closed, there is a spark across the gap between the water and the pin, and defective insulators are effected by the color of the spark. If the insulator is defective the spark is yellow and dull or bushy, and blue and sharp when the insulator is perfect.

The line will consist of six No. 1 B. & S. gage, soft drawn copper conductors. It is interesting to note that the copper from which the wire was drawn was mined at Butte and in the immediate vicinity of the station location, and is the first wire for transmission purposes drawn by the Waclark Company, of Elizabethport, N. J.

The transposition of the wires is accomplished between five pole spaces or 525 ft. The transposition is made in such a way that each leg of the circuits crosses each of the other two legs; and the circuits, as a unit, also cross each other. In making the transposition a third cross arm is used.

The two circuits can be used in multiple or independently, as desired, and each circuit is capable of carrying the full load if necessary. With the two circuits in parallel, the line loss is less than 7 per cent.

Cost.—In this interesting feature this plant shows a remarkably low figure. The entire cost, including the two storage dams and the step-down transformer equipment for the substation, will be $400,000.

In General.—Among the large contractors for power arethe Butte General Electric Company, the Butte Consolidated Street Railway Company, the Butte Reduction Works, the Colorado Smelting Company and the Montana Ore Purchasing Company.

The first named company has 27,000 incandescent lights connected, all to be operated from the Power company's circuits. In addition it will install a rotary converter to furnish current to its 550 volts direct current power circuits, and three 100 h. p. induction motors, each of which will be connected to a 125-light arc dynamo. The Butte Consolidated Street Railway Company has arranged for two rotary converters of similar size and capacity, for the supply of current to the city street railway system. The Butte Reduction Works will install one 215 h. p., 440 volt, revolving field synchronous motor, one 15 h. p. induction starting motor and two 150 h. p., 440 volt induction motors. The Colorado Smelting Company has contracted for two revolving field, synchronous motors, one of 300 h. p., 164 revolutions; and the other of 300 h. p., 450 revolutions, both on the 440 volt circuits; and three 15 h. p. induction starting motors. The Montana Ore Purchasing Company, will install one 300 h. p., revolving field, synchronous motor and two 100 h. p. induction motors.

LIQUID RHEOSTATS.

BY H. S. WEBB.

The object in view when the following tests were commenced, was to obtain some data from which the dimensions of a liquid rheostat for the dissipation as heat of a given amount of energy could be calculated, or at least estimated, when the maximum current and E. M. F. are known. These tests were rather hastily made and are far from being as complete as I should like to have them, and are published only to answer some inquiries for information on the subject.

In the first test, an ordinary Daniell jar (6¼ ins. in diameter by 8 ins. deep) with horizontal sheet-iron electrodes was filled with tap-water. It would not carry 4 amperes for over fifteen or twenty minutes, although the jar was full of water and the plates only ¾ in. apart. After that length of time it became too hot, causing great variation in the current on account of the large amount of gas liberated, much of which adhered to the under surface of the upper electrode. The difference of potential between the plates was 200 volts.

A run was made with 1 ampere and then with 2 amperes for one hour. In the latter case the voltage between the electrodes was about 71 volts, and the temperature rose to about 167° F.

From these tests it would be safe to allow a vessel with a cross section of 30.7 sq. ins. to carry from 2 to 2½ amperes when tap-water and horizontal electrodes are used.

In test No. 2, the same jar and electrodes were used as in the preceding test, but the tap-water was replaced by a saturated solution of salt water. Eleven amperes with a potential difference of 7 volts between the electrodes, which were 7¾ ins. apart, were passed through the solution for three hours and the temperature at the end of the run was 122° F., and was rising very slowly.

Although the current per square inch is much greater, the watts absorbed per cubic inch is much less in this case than when water was used. With the water carrying 2 amperes the watts absorbed would be over 10 per cubic inch, while for the saturated solution of salt when carrying 11 amperes, it would be only about .4 watt.

In test No. 3, use was made of a long, wooden rectangular trough (42 ins. × 6½ ins. × 8 ins.) with vertical, sheet-iron electrodes. The cross section of the liquid, which was a 10 per cent. solution of salt in water, was 44 sq. ins., and with 10 amperes passing through the solution for 1¾ hours the temperature rose to 95 degs. F., and was rising slowly at the end of the run.

The plates were 41¾ ins. apart, and at the end of the run the voltmeter across the terminals read 20. This gives a current density of nearly ¼ ampere per square inch and .11 watt per cubic inch. These values are too low to be considered maximum values, for this cross section of a 10 per cent. salt solution would probably carry 13 to 15 amperes safely.

It appears that as the amount of salt in the solution is increased from zero to saturation, the maximum current-carrying capacity is increased, but the watts absorbed per cubic inch are less.

A very small addition of salt to tap-water makes the solution a much better conductor than the water, and reduces greatly the safe maximum watts absorbed. In using glass vessels, such as Daniell jars, there is danger of cracking the jar if the temperature rises much above 165 to 175 degs. F.

In test No. 4, an ordinary whiskey barrel, filled up with tap-water, was used. Two horizontal circular iron plates ($\frac{3}{16}$ in. thick) were used for electrodes. The diameter of the inside of the barrel was approximately 19½ ins. With the two plates 26⅜ ins. apart a difference of potential of 486 volts gave a current of 2.6 amperes. With the plates ⅞ in. apart, 228 volts gave 35.5 amperes at the end of one hour when all the water in the barrel was very hot (175 degs. F.), and there was quite a good deal of gas given off. The current density in this case was about .12 ampere per square inch, and the watts absorbed 30.5 per cubic inch. If it were not for the large amount of water above both electrodes, it is doubtful if this current density could have been maintained.

In test No. 5 a rectangular box, in which was placed two vertical sheet-iron plates, was filled with tap-water. The distance between the plates was ⅝ in., and with a difference of potential of 414 at start and 397 at end of the run, a current of 35 amperes was kept flowing for 35 minutes. Cold tap-water was kept running in between the electrodes at the rate of 6.11 lbs. per minute (about $\frac{1}{10}$ cu. ft.), by means of a small rubber tube about ¼ in. inside diameter. This test is very interesting in comparison with the preceding. The current-carrying capacity, .3 ampere per square inch, was more than double, and the energy absorbed 183 watts per cubic inch, more than six times as great as in case where running water was not used.

The temperature in some places between the plates occasionally rose as high as 205 degs. F., and it was necessary in order to avoid too violent ebullition, to keep the inflowing stream of water directed along the water surface between the two plates. Less water would not have been sufficient, and, of course, by using more water, the temperature could have been kept lower, or with the same temperature the watts absorbed could have been increased.

When a large current density is used, there is considerable decomposition of the iron electrodes when either salt or pure water is used, and in the case of horizontal electrodes, the under surface of the top plate may become covered with bubbles of gas, making the resistance between the plates quite variable. For large current density, a horizontal top plate is not advisable, unless a large number of holes are drilled through it. A better form for the top electrode would be a hollow cylinder long enough to give sufficient surface. Washing soda is often a convenient substance to use instead of salt.

If, from experience, the size of a liquid rheostat for absorbing a given amount of energy cannot be estimated, the dimensions may be calculated approximately as follows: Suppose, for instance, it is desired to absorb 60 amperes at 40 volts difference of potential between the electrodes. Now, it is inconvenient to obtain a saturated solution of salt, and to use tap-water would require too large a cross-section—especially if a barrel or trough is to be used—in order to have the resistance with the plates at a safe distance apart, small enough to give 60 amperes with 40 volts.

Let us try a 10 per cent. solution of salt. Suppose the maximum current this will carry is ¼ ampere per square inch, which will give a cross-section of the solution of at least $60 \div \frac{1}{4} = 240$ sq. ins. Now, the specific resistance per inch cube (*i. e.*, the resistance between two opposite surfaces of a cube whose side measures 1 in.) of the 10 per cent. solution of salt used in test No. 3 was 2.12 ohms. The drop, CR, will be $2.12 \times \frac{1}{4} = .53$ volts per inch length of solution between electrodes. Hence, the electrodes will have to be $\frac{40}{.53} = 75$ ins. apart. This would require about three barrels connected in series. This was taken merely as an illustration, because its specific resistance was known when the current density was ¼ ampere per square inch. This solution, however, will carry safely ⅓ ampere per square inch, but I used the previous figure since I did not know its specific resistance for this current density, because its specific resistance will be lower for a larger current density on account of the higher temperature which it will have, for the resistance of a solution decreases as its temperature increases.

To reduce this length would require a solution of higher specific resistance, that is, a solution containing less than 10 per cent. of salt, and an increase in the cross-section, since the maximum carrying capacity also diminishes as the percentage of salt diminishes. Only approximate calculations are useful because variations in temperature, amount of salt actually in solution and the rate at which heat can be radiated, all combine to give results which may vary widely from those calculated.

As a matter of fact, it is seldom necessary or advisable to use a solution containing over 2 or 3 per cent. of salt. The best way to add salt to a liquid rheostat is to make a strong solution in a separate vessel and add as much of this solution as is needed. This avoids the annoying increase in conductivity of the solution which happens when the salt itself is added and is gradually dissolved.

Liquid rheostats are ever so much more satisfactory for alternating than for direct-current testing. The electrodes and solution are practically free from decomposition, and a given cross-section seems to be able to carry a larger alternating than direct-current—probably due partly to the absence of the scum on the surface which hinders the radiation of heat.

ARMATURE WINDINGS.

ARMATURE CONNECTIONS AND DIAGRAMS—I.

BY PROF. ARTHUR L. RICE.

In a properly designed armature, the circuits must be in electrical balance, the armature must be in mechanical balance and the conductors must be connected so that their E. M. Fs. are in series throughout any one circuit. To fulfill these conditions, there must be the same number of conductors in each path through the armature, the connections must be such that at all times the pressure in each path is the same, the winding must have mechanical symmetry and the conductors must be so connected that in none of them is the current opposed to the E. M. F.

Without going deeply into the relations of magnetic field, current and motion, it may be helpful to glance at Fig. 1 and note that the lines of magnetic force flow from the north pole to the south; that when a conductor moves through the field it tends to bend the lines with it as if they were elastic cords; that the lines tend to curl up around the conductor and set up an E. M. F. in it; and that, if the direction of curling of the lines around the wire is such as would force a right-hand screw ahead, the E. M. F. tends to produce current flow in the direction of motion of the screw. Also, it will be convenient to remember that, with right-hand rotation (which will be used throughout these articles), the current in a conductor under a north pole should flow towards the back, and under a south pole towards the front of the machine.

The simplest form of armature is the Gramme ring. In this type only the conductors on the outside of the core are active, *i. e.*, produce any E. M. F. The current must flow from front to back in all active conductors under a north pole, so that the front end of one conductor must be joined to the back end of the one next it; in like manner the front end of each active conductor under a south pole must be joined to the back end of the adjacent one so that current may always flow forward in the active conductors under a south pole. The conductors on the inside of the core are to make these connections. (See Fig. 2.) The continuous winding thus formed may be spread over the entire surface of a smooth core, or, more commonly, placed in the slots of a toothed core.

There may be any number of conductors connected together before a lead is taken to the commutator, the only condition being that there shall be the same number of conductors joined in between each two commutator bars. The leads are usually brought out straight to the commutator bars. The lead from the inside conductor on one coil must be joined to the same commuator bar as that from the outside conductor on the adjacent coil, in order that the series connection of conductors may not be broken.

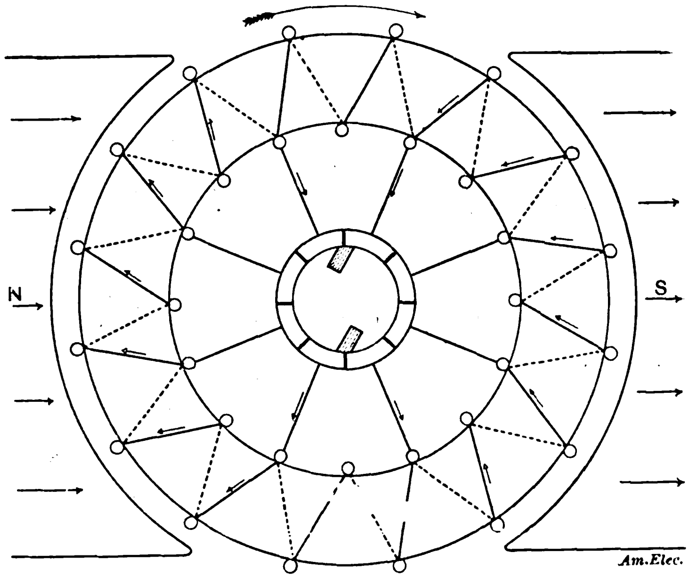


FIG. 3.—GRAMME RING WINDING.

The method of winding and connecting is too obvious to need comment. At the top and bottom of the armature, in a two-pole machine, there will be a point where the currents will meet and tend to flow against each other; these are the points to which the brushes should be connected, *i. e.* they should be placed in the commutator bars which are connected to those points (see Fig. 3). There will be as many commutator bars as coils.

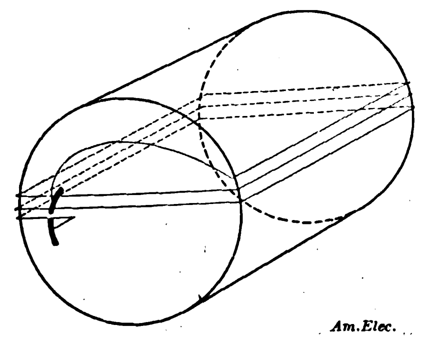


FIG. 4.—DRUM WINDING.

This is the simplest form of armature to wind and connect, but there is a large proportion of inactive wire on account of the inside connections. To lessen the dead wire, the drum winding is used. In that form, the conductors on the outside of the armature are connected by wires running across the end on a chord of a circle. Take the case of a two-pole armature having twelve coils; each coil is really two conductors, so that there will be twenty-four conductors, as in Fig. 5. The front end of each conductor must be joined to a commutator bar and the back end of each conductor to the back end of another conductor. In order that the conductors may be in series, the back end of a conductor under a north pole must be joined to the back end of a conductor under a south pole; and to get a symmetrical winding, conductors as nearly opposite as possible should be joined. There are to be as many commutator bars as coils, since an end from each of two coils is joined to a commutator bar; also, since there are to be two paths through the armature, there must be an even number of coils, so that there may be the same number in each path or circuit. Number the conductors and commutator bars as shown.

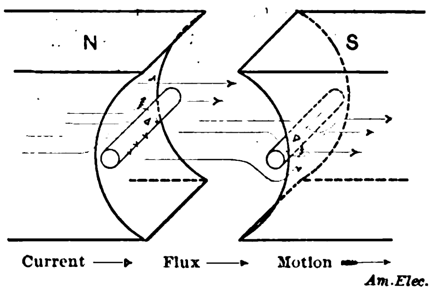


FIG I.—GENERATION OF E. M. F.

Suppose that the commutator is set so that the bars come opposite the odd-numbered conductors; the natural connection is from conductor 1 to commutator bar 1, thus giving a straight lead. Conductor 1 must be connected on the back end, to a conductor that is not over a commutator bar, in order to get symmetrical winding; it may connect to either 12 or 14; suppose it be connected to 12. The front end of 12 must be connected to some commutator bar; it is desirable to keep the end connections as short as possible, yet the connection must be to a conductor under the north pole, and, for the sake of symmetry, nearly opposite. The connection is therefore carried to commutator bar 2; as conductor 1 has been connected to bar 1 directly underneath, each odd-numbered conductor must be connected to the bar under it; hence bar 2 is connected to conductor 3. In joining conductor 1 to 12, the advance was eleven conductors; therefore, from 3 the advance must be eleven, or to conductor 14; from 12 the connection was to 3, or a retreat of nine, hence from 14 the retreat is nine or to 5 through bar 3; the number of conductors advance on the back is called "back pitch;" that of retreat on the front, "front pitch."

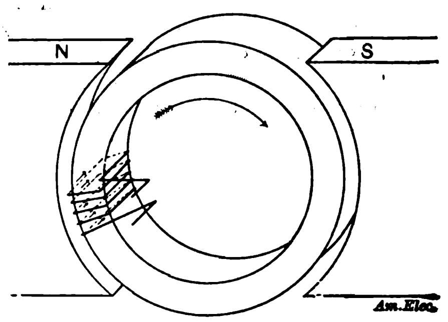


FIG. 2.—GRAMME RING WINDING.

This form of winding, alternately advancing and retreating, is called "lap winding" because the coils lap over one another. (Note that the back connections have been drawn in dotted lines, and the front connections in full lines.) The rest of the connection follows the same rule, and may be tabulated thus:

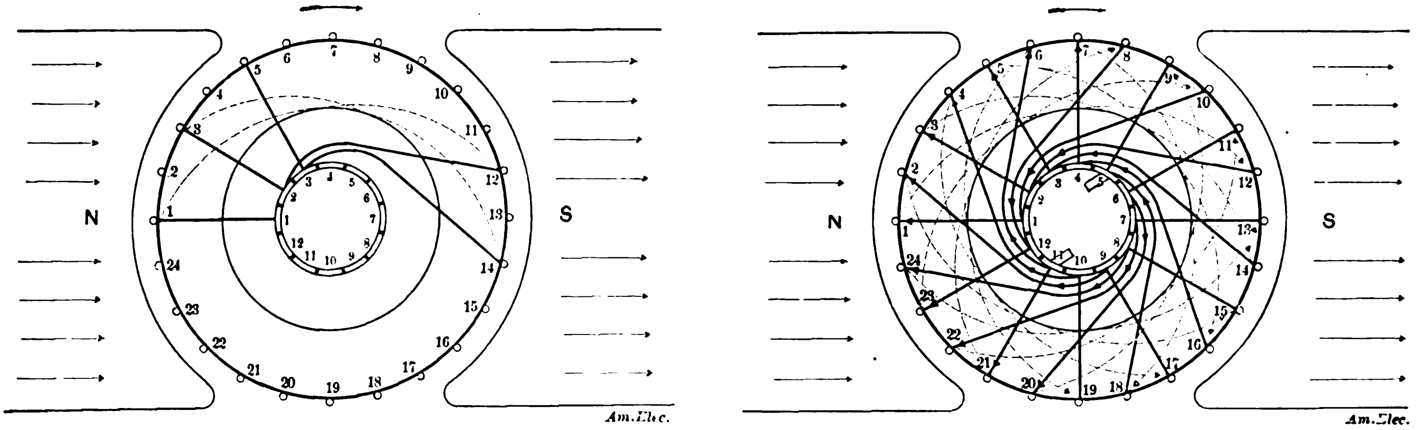
Bar 1	to conductor 1,	back, to 12,	front
" 2	" " 3,	" " 14,	"
" 3	" " 5,	" " 16,	"
" 4	" " 7,	" " 18,	"
" 5	" " 9,	" " 20,	"
" 6	" " 11,	" " 22,	"
" 7	" " 13,	" " 24,	"
" 8	" " 15,	" " 2,	"
" 9	" " 17,	" " 4,	"
" 10	" " 19,	" " 6,	"
" 11	" " 21,	" " 8,	"
" 12	" " 23,	" " 10,	"
" 1			

and the starting point has been reached, all the conductors and bars having been connected. From a table like the above, called a winding table, it may be determined, without the labor of drawing a complete connection diagram, whether or not an armature is to connect properly with a given number of conductors and pitch.

The completed diagram is shown in Fig. 6. It is desirable to test the winding and see if it fulfills the necessary conditions. First, where are the brushes to be placed to collect current?

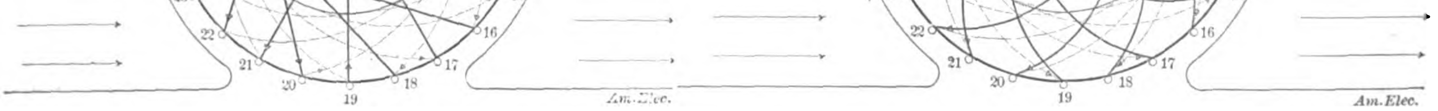
Bear in mind that, with right-hand rotation, as shown by the arrow, the E. M. F. under a north pole tends to set up current from front to back of the machine, *i. e.*, away from the observer; hence under a north pole the current should flow away from a conductor in the back (dotted) connection, and towards it in the front (full) connection, and *vice versa* under a south pole.

Starting with conductor 1, current should flow away on the back connection to 12, from 12 to 3 through bar 2, and so the current may be traced successively through conductors 14, 5, 16, 7 and 18, the current being, so far, in unison with the E. M. F. If the course be continued, it must pass through 9; but in 9 the E. M. F. tends to send current towards the front, and the next conductor, 20, tends to send current towards 9; current should, therefore, flow into bar 5 from both directions, and a brush should be placed on that bar to carry current from the armature to the outside circuit.



FIGS. 5 AND 6.—LAP WINDING.

Returning to conductor 1, and going in the opposite direction, current comes to 1 from 10, 23, 8, 21, successively in unison with the generated E. M. F.; if the course be followed further, in 6 the E. M. F. is found tending to set up current towards the back end, *i. e.*, away from bar 11, so that current must flow into the armature from bar 11 and the other brush should be placed on that bar. Continuing from 6, the current would flow through conductors 19, 4, 17, 2, 15, 24, 13, 22, 11, 20 and 9 to the other brush already placed on bar 5, and will always flow in the same direction as the E. M. F.



FIGS. 7 AND 8.—LAP WINDING.

The winding has, therefore, the current always in the same direction as the E. M. F.; moreover there are twelve conductors in each path from brush to brush, and diametrically opposite conductors are in different circuits so that, for symmetrical flux distribution, the E. M. Fs. of the two circuits will be the same. Since the diagram has geometric symmetry, the winding will be in mechanical balance and the conditions stated at the outset are fulfilled.

In the actual winding of a machine, it is probable that, instead of two conductors to a coil, there would be several; those lying at 1 would be connected in series with those lying at 12 by end connections front and back (See Fig. 4), and the ends of the coil brought out and connected as before, the same being done for the other coils. In the process of winding, coil 1-12 should be put on first, then 24-13; next 7-18, and afterwards 6-19; next 3-14, and after that 2-15 and so on; this ensures easier winding, better shaped heads and more even resistance than would be gotten by beginning with one coil and winding in succession around the armature.

If, after connecting conductor 1 to conductor 12, the front lead had been carried from 12 eleven conductors ahead, to bar 12, and thus joined to conductor 23, and all the other front leads from even-numbered conductors had been changed correspondingly, the result would have been a "wave" winding, so called because the connection always advances like a wave traveling around the armature; the front and back pitch would both be 11. The winding table would be as follows:

Bar	1	to conductor	1,	back to	12,	front.
"	12	" "	23,	" "	10,	"
"	11	" "	21,	" "	8.	"
"	10	" "	19,	" "	6,	"
"	9	" "	17,	" "	4,	"
"	8	" "	15,	" "	2,	"
"	7	" "	13,	" "	24,	"
"	6	" "	11,	" "	22,	"
"	5	" "	9,	" "	20.	"
"	4	" "	7,	" "	18,	"
"	3	" "	5,	" "	16,	"
"	2	" "	3.	" "	14,	"
"	1					

The diagram of connections would be as shown in Fig. 7. The winding of the coils would be the same as before, the difference being in the connections to the commutator.

In the case of a two-pole machine, there is little preference between the lap and wave forms of winding, the former giving somewhat shorter end connections. In the case of a lap winding, the only condition is that the number of coils shall be the same as the number of commutator bars, and the number of bars must be even to allow of equal division between the brushes. The pitch, front and back, must be so chosen that an odd-numbered conductor will be connected to an even-numbered one, and *vice versa*, alternating in passing around the circuit.

The connection to the commutator used above (Fig. 6) gives the position of the brushes about half way between the poles. If desired, the front leads from 1 and 10 may be carried to a bar about half way between the conductors, say, to bar 3, thus equalizing the length of the leads. If the same change be made in all the connections, the position of the brushes would be advanced, approximately, 90 degs., and the armature would be as in Fig. 8. The brushes may thus be made to come in any position desired to accomodate the mechanical design of the machine, or to give the appearance of a small brush lead.

The same process of winding and connecting would be followed for an armature having a large number of coils and commutator bars, but the diagram would, of course, be more intricate and the winding table longer.

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DESIGNING DYNAMOS AND MOTORS.

SMALL MOTORS.

BY CECIL P. POOLE

The calculation of the magnetic and electric details of dynamos and motors naturally begins at the armature, and for best results all the characteristics of the armature should be determined before any work is done upon the field-magnet data. The controlling factors in armature design are the iron and copper losses, and these must be assumed roughly and experimental calculations made in order to obtain a foundation for definite proportions.

For example, suppose it is desired to design a $\frac{1}{8}$ HP bipolar motor with a toothed armature to work on a 110-volt circuit. So small a machine would be given a series field winding because of the expensiveness of winding both field and armature for 110 volts. Allowing one-half of the total energy for consumption in the field and armature, the counter E. M. F. will be 55 volts. The current will therefore be $\frac{746}{16} \div 55 = 0.85$ amperes approximately, but some allowance must be made for the friction loss, so 1 ampere may as well be assumed for the current. This will make it a 110-watt machine. Anyone familiar in the remotest degree with the general run of sizes will know that the armature will be somewhere near 1½ or 2 ins. in diameter. Taking the larger size, the first step will be to determine the size of the slots. In so small a machine eight coils will be enough, so that there will be eight slots. About one-half of the outer circumference should be iron, and as the circumference is 6.28 ins. the sum of the angular width of the teeth will be about 3 ins.; for convenience assume 3.08 ins. for the teeth, leaving for the sum of the slot widths 3.2 ins., or .4 in. each. It is safe to make the slots square, or as near so as will make the winding fit comfortably; so for the present the slots are .4 in. × .4 in.

A.—The size of the wire comes next. The output being 1 ampere, each wire will carry ½ ampere, so that No. 24 or No. 25 wire will be about right for the usual depth of armature winding. No. 24 measures 28 mils over insulation; the slot insulation should be at least 0.025 in. thick, taking up 0.05 in. of the width and leaving 0.35 for wire; 12 No. 24 wires, side by side, measure 0.339 in. over all, so that the slots would have to be $0.339 + 0.5 = 0.389$ in. wide, to be exact, but the insulation will spread enough to let the width remain 0.4 in. The depth of the slot deducting the insulation on the "floor" (0.025 in.) is 0.375 and this will accommodate 13 layers of No. 24 wire, so that there will be $156 \times 8 = 1248$ wires all around the armature.

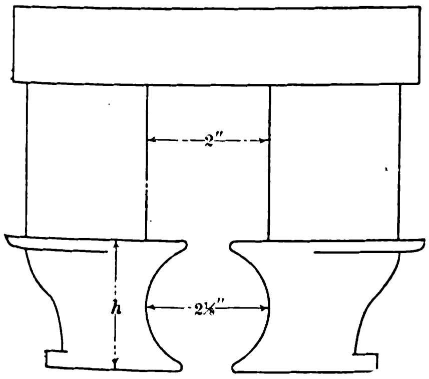
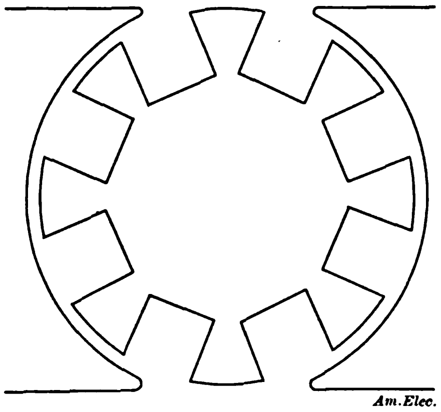


FIG. 1.—ARMATURE DISC.

B.—Allowing an armature speed of 300 r. p. m., the total number of magnetic lines passing through the armature must be, to generate 55 volts,

$$\frac{55 \times 10^8}{1248 - \frac{300}{60}} = 89{,}743.$$

As the lines will pass through less than half of the teeth, three teeth will have to carry them, and the density of the flux in the teeth will determine the length of the armature.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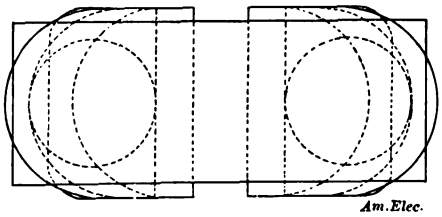
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FIG. 2.—FIELD FRAME.

The width of one tooth averages practically $\frac{(1.6\,\pi) - (8 \times 0.4)}{8} = 0.228$ in., and three teeth give 0.68 in. angular breadth of iron pathway. The teeth should be saturated magnetically, and as an experimental figure, a density of 90,000 lines may be assumed. As the total flux required is 89,743 lines, only 1 sq. in. of aggregate cross-section in the three teeth will be needed; the angular width being 0.68 in., the axial width will need to be 1.5 ins., so that the armature may be made 1½ ins. long, provided the iron loss is not excessive.

The so-called hysteresis loss in the teeth will be approximately 9 watts per cubic inch, or a trifle over $\frac{7}{10}$ watt for all six teeth (three on each side). The density in the body of the armature is $\frac{89{,}743 \text{ lines}}{1.8 \text{ sq. in.}} =$ 49,860, which is low for sheet iron. The iron loss would not exceed 6¼ watts, making less than 7 watts for the entire core, or 6.36 per cent. of the output, which is reasonable.

The armature dimensions, then, may remain as first assumed: Length, 6.36 ins., diameter, 2 ins.; 8 slots, .4 in. wide and 0.4 in. deep, containing coils of No. 1½ wire 13 layers deep and 12 turns wide in each slot. (As each slot will carry one-half of each of two coils, each individual coil will contain 78 turns.)

C.—The armature being 1½ ins. long, the pole-pieces will be 1½ ins. long, and the height, *h*, should be not less than the diameter of the armature—2 ins.—with the corners rounded away until, with a bore of 2⅛ ins., each polar arc embraces about three-fourths of one side of the armature. The area of the field cores will depend, of course, upon the density employed; an average grade of wrought-iron shows a curve, the "knee" of which extends from about 75,000 to 85,000 lines per square inch, and the middle of the knee is a good point at which to work small magnets. Assume temporarily a density of 77,400 lines (12,000 gausses).

Besides the total flux of 77,000 lines figured for the armature, the magnet will have to supply from 35 to 50 per cent. more lines which are lost by leakage; in so small a machine the leakage may be arbitrarily assumed to be 40 per cent.; if it be more the speed will be slightly higher and if less it will be lower. With 40 per cent. leakage the total flux generated will be $77{,}000 \times 1.4 = 107{,}800$ lines; if the density be 77,400 lines the sectional area of the limbs will be

$$\frac{107{,}800}{77{,}400} = 1.4 \text{ ins. roughly}$$

—say 1⅜ ins. in diameter for round cores, which will give an area of 1.48 ins. The density in the yoke should be as low as possible to lessen the leakage at the corners.

The width of the yoke must be at least 1⅞ ins. in order to cover the ends of the cores, and it should be wide enough to "back up" the coils; 2 ins. across will not be excessive. If cast-iron be used the density should be not over 30,000 lines; if wrought-iron, about 60,000 to 65,000 lines. The flux through the yoke is usually from 5 to 15 per cent. less than that through the cores, owing to the leakage at each end of each coil; the maximum flux being 107,800, that in the yoke will be about 97,000. A cast-iron yoke must have, therefore, a cross-section of $\frac{97{,}000 \text{ lines}}{30{,}000 \text{ density}} =$ 3.233 ins., and the thickness will be $1\frac{3}{16}$ ins., 2 ins. having been taken as the width. A wrought-iron yoke, at 65,000 density, would have a cross-section of $\frac{97{,}000}{65{,}000} = 1.49 +$ ins. (say 1½) or a thickness of ¾ in. (If cast-iron be used the field cores should be let into the yoke with a taper fit instead of being simply "butted" to it).

D.—The length of the cores depends largely upon the C^2R loss in the field coils, as with constant potential at the terminals and a fixed size of wire and depth of winding, the exciting power of a coil is the same for any length within reasonable limits, the only effect of lengthening a coil being to reduce the heat loss. The length of the cores

TABLE OF AMPERE-TURNS PER INCH OF LENGTH FOR VARIOUS MATERIALS AT DIFFERENT DENSITIES.

Lines per sq. cm.	Lines per sq. in.	Cast Iron	Cast Steel	Wr'ght Iron	Sheet Iron
2000	12.900	4	......	......	....
3000	19.350	7	......	......	1.5
4000	25.800	12	......	4	2 5
5000	32,250	22	......	5	3.2
6000	38.700	50	8	6	4.2
7000	45.150	85	9	7	5.2
8000	51,600	162	10	8	6.4
9000	58,050	......	12	10	8.1
10000	64,500	......	14	12	10.2
12000	77,400	......	20	19	17.5
13000	83,850	......	26	25	24.0
14000	90,300	......	38	36	32.0
15000	96,750	......	60	58	50.0

may be temporarily assumed as two to three times their diameter, say 3 ins.

E.—**In computing ampere-turns, the writer figures in ampere-turns per inch of length instead of working out a permeability or reluctance of the circuit, having prepared from a number of magnetic tests the accompanying table giving the ampere-turns per inch required by wrought-iron, sheet-iron. cast-steel and cast-iron at various densities,**

The densities, etc., in the various parts of the circuit are summed up as follows:

	Total Density.	Length of Path.	Amp. turns.
Armature body	49,860	1.6 ins.	8
Armature teeth	89,740	0.8 in.	26
Air-gap	$\frac{77.000}{5 \text{ ins.}} = 15.400$	⅛ "	603
Pole-pieces (cast	$\frac{97.000}{5 \text{ ins.}} = 19,400$	3 ins.	21
Field-cores	$\frac{107,800}{1.48} = 72,838$	6 "	98
Yoke (wrought)	$\frac{90\,000}{1.25} = 72,000$	3¾ "	57
Total ampere-turns			813

As the current at full load is to be 1 ampere, the ampere-turns and total convolutions of wire are identical—813; the winding being in two coils 814 will be a more convenient number. In the case of a small series motor on a constant potential circuit both the voltage and current are regarded as constant in calculations, full load only being considered.

The counter E. M. F. of the armature being put at 55 volts, the losses must be deducted from the remaining 55 volts so far unaccounted for. The iron loss was shown to be a trifle under 6.95 watts, so 6.95 volts (the current being 1 ampere) are absorbed here; the resistance of the armature, hot, will be 3.3 ohms, which takes up 3.3 volts more, and 0.25 will certainly be lost in connections. This leaves available 44½ volts (or 44½ watts). It is not advisable to dissipate much more thon ⅓ watt per sq. in. of coil surface, and as the two coils will have from 25 to 30 sq. ins. of surface, 10 watts will be about the limit for the C^2R loss. This means 10 volts drop in the windings. Assuming a depth of $\frac{3}{16}$ in. for the wire on the core, the average length of each turn will be 4.9 ins., with armature winding, and as there are 814 turns the total length will be 3988½ ins. on the cores, and 3990 ins. or 332½ ft. including connections.

If 332½ ft. must have a resistance of 10 ohms, 1000 ft. will have 30 ohms. The nearest *larger* size (which should always be taken) is No. 24 B. & S. gauge, having a resistance of 0.257 ohms per 1000 ft. at 75 degs. F.; this will rise to about 30 ohms hot. Allowing for insulating heads, each coil will be 98 turns in length, so that there need be only 4⅙ layers of wire to give the required number of turns total. This will reduce the depth of winding to scant ⅛ in., and the mean length of each turn to 4.7 ins. The revised total length will therefore be $\frac{4.7 \times 814}{12} =$ 320+ ft. and the resistance 9.6 ohms, leaving 34.9 ohms for the extraneous resistance.

It is obvious that by making the magnets longer the energy expended in the outside resistance could be applied to them and a higher efficiency obtained; it is also obvious that the armature might be made longer and the fields larger so as to obtain a greater number of lines of force and consequently a higher counter E. M. F., thus eliminating the outside resistance. The gain in efficiency, however, does not justify the extra first cost in so small a machine; in fact, it is rather too efficient as it is, the electrical losses being only one-half of the total applied energy.

It is easy to see that the lower the voltage, within the ordinary limits, the more efficient a machine of any size may be made for a given ratio of cost to output, or the lower the cost for a given output and efficiency. In the case of the particular motor here described, if the impressed E. M. F. were 75 volts no extraneous resistance would be required and the electrical efficiency would be about 66 per cent. instead of 50.

FUSES vs. CIRCUIT BREAKERS.

SOME FACTS AS TO FUSES AND CIRCUIT-BREAKERS.

BY JOSEPH SACHS.

It is to be regretted that a discussion regarding the relative merits of technical apparatus cannot be freely carried on without some of the participants therein indulging in uncalled-for personalities. The writer has attempted to show in previous articles, appearing in this journal, the relative advantages of a possible protective device which is practically unknown to the commercial electrical public, and an electromagnetic mechanism which has had ample advertising and usage to create a most thorough familiarity with its characteristics.

One of the writers who takes upon himself the defense of circuit-breakers says that "Personally, while I have no interest whatever in circuit-breakers at this writing, I took up the cudgel owing to the speciousness of the arguments advanced. In looking for the animus of the attacks I am informed that both writers are financially interested in cartridge fuses." If I am correctly informed, the writer of the above has a decided interest in circuit-breakers at this writing.

Mr. Harrington, quoting a statement that "a properly designed fuse will open the circuit as quickly on heavy overloads as a circuit-breaker," says that if this assumption is granted as correct, "then such engineers as Dr. Cary T. Hutchinson, C. O. Mailloux, Gano S. Dunn, etc., must be mistaken." In reply to this misleading comment, it is merely necessary to say that this discussion refers to the enclosed fuse, and not the open fuse which the above gentlemen have condemned, in common with the writer and all other advocates of the enclosed fuse. Their engineering ability is undisputed, but being as yet quite unfamiliar with the improved types of fusible cut-out, their decision to use circuit-breakers for certain classes of electrical protection could scarcely be otherwise, considering that the other available protection has been the common type of open-air fuse. Yet so thoroughly do these gentlemen believe in protection that they almost invariably guard against any unfaithfulness on the part of the circuit-breaker by using, in conjunction with it, an open-air fusible cut-out.

Now as to the statement, "A properly designed fuse will open the circuit as quickly on heavy overload as a circuit-breaker" of which it is said that both Mr. Cutler and the writer are very positive. Mr. Cutler makes this statement in his last article. What reason has Mr. Harrington to differ therefrom? Has he ever compared the relative action of circuit-breakers and such fuses as are mentioned as "properly designed" fuses in this discussion? It may be most emphatically stated that a properly designed fuse is not an open-air fuse of any arbitrary length, placed in any contact block, and run at about 50 per cent. below its actual carrying capacity, with an overload factor of perhaps 25 per cent. above. Let Mr. Harrington try an improved fuse which will act at about 10 to 15 per cent. overload current in a short-time interval, and compare it with a circuit-breaker having the same carrying capacity. Probably he will then find his differences not quite so emphatic.

Another luminous argument advanced by the same writer is that "no two manufacturers would produce a similar type of fuse, and the same unfortunate diversity of conditions, sizes, shapes, alloy, length, position, method of enclosure, kind of contacts, character of current and age; thus the fuses placed upon the market would soon assume the proportions that now bewilder the layman upon investigating the fuse question."

Notwithstanding the fact that this objection always accompanies fuses, none are expected to think of the many different forms of circuit-breakers, their different sizes, shapes, methods of operation, etc. Who has ever suggested the use of the electromagnetic trip arrangement used in the circuit-breaker of one make, applied to the switching and circuit-controlling mechanism of another? When we buy such a device we usually expect both of these essential elements to be adapted to one another.

Fuse cut-outs must be considered in exactly the same light. The fuse and its receptacle or contact block are one complete device, in which each element has its own special function. It is no more essential that the fuses of one manufacture should be used in blocks of another, than it is that magnetic operating mechanisms adapted to one form of switch device should be applied to another. The variety of magnetic circuit-breakers on the market at the present time, and still developing, promises to be quite as bewildering to the layman as any present aggregation of fusible-cut-out protective appliances.

Another point may be made as to "character of current and age." Has Mr. Harrington ever designed a direct-current circuit-breaker which would work at the same rating on alternating current? Has he ever found that age has a peculiar affinity for the releasing mechanism of an automatic electromagnetic circuit-breaker? There are few who have used circuit-breakers in all sizes who will not bear witness to that peculiar sticking disability which old age brings on, and which is most decidedly an infirmity in the wrong direction. Such infirmities may exist in fuses. In some they are of the same nature as those of the circuit-breaker. It is, however, but just that the writer should here assert that this infirmity, if at all a characteristic of the fuse mentioned in a previous article, is in the opposite direction. It will by no means permit excesses due to sticking.

Mr. L. W. Downes in his article takes exception to a number of my previous statements. He should, however, have credited the writer with a fair knowledge of the essential elements for fuse calibration. No mention of the fact that "a fuse calibrated in this way at 60 degs. would not by any means carry the same current at 80, 90 or 100 degs." was made, because it was assumed that the necessity of such "a fixed standard for the surrounding temperature" was well understood.

By including a time factor for, say, the smallest percentage of operating current, and perhaps also giving the current, which will operate almost instantly, say, in one second, readily enables the user to understand the exact working of the devices at various intermediate points of overload, and to better plan his protecting devices.

Mr. Downes accuses the writer of "failing to realize that an enclosed fuse constructed as described is quite worthless as a protective device, except in cases of short circuit, without the chamber; for the reason that its maximum carrying capacity changes with the length of time the fuse is in circuit, gradually becoming less as the mass of surrounding material becomes heated, with a proportional change in its blowing time, for any given overload factor."

Such a realization is scarcely essential in order to produce a fuse of the type mentioned, which will give as good results as those described by Mr. Downes. It is unnecessary to give at this moment the exact methods adopted to produce this result, but it may be positively stated that it has been accomplished and without an air chamber such as Mr. Downes uses. A full description of these methods will shortly appear. It may be well to realize for the present, that this difference in time of action between cold and hot points is almost entirely a question of the heat capacity of the environment. This being the case, Mr. Downes will perhaps appreciate that by a suitable proportioning of the latter, the difference in time between the hot and cold operation can be minimized. It may also be said that the idea that "the calibration of such fuses to their maximum carrying capacity at a given temperature is, however, a very tedious process, requiring the most careful attention for many hours, as with large sizes it requires from eight to ten hours for the mass to reach its maximum temperature," is also erroneous and depends upon the same consideration.

Quoting again, Mr. Downes claims that the writer stated in regard to fuses of his design "that they can be built to blow on 10 per cent. or even less above its continuous running point." * * * "In the assumption that it is impossible to construct air-suspended fuses, with a short-time interval, is another error, and it is possible to secure almost any desired time factor by a suitable adjustment of the various parts."

It is not intended to credit the fuse with any peculiarly remarkable performance in the above without considering time. When, however, both time and overload are considered, a fuse which will operate at, say, 10 per cent. overload current in a *very* small time interval, is certainly notable. Owing to a peculiar action in the fuse described, this time interval with a minimum acting overload, can be made very small, and, it is fully believed, attain results unattainable with an air-suspended fuse.

By no means is it intended to propose the general utilization of a fuse operating at 10 per cent. overload in one second. The one-second operating point mentioned is in no way connected, or intended to be connected, with the 10 per cent. overload. The statement will be found to read, "whose one-second operating point leaves a certain factor of safety in the apparatus to be protected." The fuse therefore would operate in one second at a current which would leave a large factor of safety for the *same time interval* in the apparatus to be protected, but this current may be far above the 10 per cent. point.

As it is expected that the writer will shortly be able to go into details of this new form of thermo-electric protecting device, it is deemed advisable to simply refute and not advance new features and characteristics. It may be said that in the development of this appliance many peculiar features were found which, when combined, produce a protecting device with the advantages of both the ideal fuse and the present forms of circuit-breaker.

THE ENCLOSED FUSE.

BY D. J. CARTWRIGHT.

In discussing this question, I am not influenced by any prejudice against my competitors in the field. My object is simply to state the main features of various protective devices as they appear to me after careful study.

Which is the more reliable, a mechanical device with its many springs and its liability to get out of adjustment, or a thermal device containing no springs, no poor contacts, no friction, and which can be installed by any man of ordinary intelligence? A mechanical device for opening the circuit with a given current in amperes in a given time has been long sought; fuses and circuit-breakers have been designed for this purpose and there are devices that will do it.

There are various circumstances to be considered in selecting a proper cut-out. A motor in starting will require a greater number of amperes than could be maintained indefinitely without danger to the insulation of the machine. The insulation is likely to be destroyed also by the quick breaking of the circuit. For these reasons, it is desirable that the cut-out, whether an electro-mechanical or a thermal device, should have a time limit. In a central station where men are in constant attendance, a mechanical device may be more economical and serve to protect a machine from dangerous overload. But, away from the station, a device not liable to get out of order should be used; one, in fact, requiring no attention and which can be installed in any convenient location.

When a fuse melts, it must be removed and another put in its place. To do this requires some little time and exposes the operator to more or less danger if *naked* fuses are used; this danger is entirely eliminated by using enclosed fuses.

When a circuit-breaker in a station operates, all that becomes necessary is to close the circuit. If it is used on a power system, a sufficient time must elapse to allow for the cutting out of all the motors which are supplied by the machine. The use of a mechanical circuit-breaker is not a saving of time—in fact, it saves only the cost of a fuse.

The defects of naked fuses are well known, but a few words will not, however, be out of place.

The carrying capacity of a naked fuse is affected by a draught of air, by its position, either horizontal or vertical, by the substance it may be in contact with, by its length, by the composition of the fuse-wire, and many other reasons which increase or decrease the melting point of the fuse.

On a short circuit of 220 volts or greater, with an open fuse in any form of cut-out now in common use, either the cover, the side, or the terminals are destroyed, or partially so, and in many cases a new cut-out must be put in. It is important that the fuse may be handled with impunity even when in the circuit.

I have designed a new enclosed safety fuse constructed and operated in a novel way and producing, I believe, the most desirable results in a better and more efficient manner than any other device of its class. It can be provided with means for preventing the ferules on the ends of the fuse case making contact with the circuit.

In this device, the fuse is so constructed that the wire melts within the central section and the heated air and gases formed thereby, in forcing themselves to the outer or end sections, blow out the arc. This fuse can be used on any pressure less than 2200 volts. It will not maintain an arc between its terminals when short-circuited on the mains of a 2200-volt, 120-KW alternating dynamo.

The cut-out consists of two parts: the base and tube. The base is made of slate, and the tube of fibre tightly closed. Fig. 1 represents the cut-out complete, Fig. 2 shows the fuse with the central part of the case cut away to show the fuse-wire in the central air-space and also the filling at each end; and Fig. 3 represents a 50-ampere fuse cut open after it had been short-circuited on a 500-volt circuit of 450-KW capacity, and it opened the circuit without noise or flash. This fuse would have carried 50 amperes of current indefinitely. It would have melted on a current increase of 25 per cent. in less than three minutes.

In testing, a fuse that carried 60 amperes of current for three hours was allowed to cool for 15 minutes; the current was then increased to 75 amperes, and the fuse operated in 2 minutes 48 seconds, an increase of

25 per cent. over the carrying capacity of the fuse.

This fuse has a definite length, cannot come in contact with any foreign substance, can be operated in a room filled with inflammable gas, and it will open the circuit in in a predetermined time on a given current in amperes.

Owing to the peculiar construction of this enclosed safety fuse, a tube or case 3 ins. long will open the circuit where other devices require more than twice that length operated under the same conditions and with a fuse of the same carrying capacity.

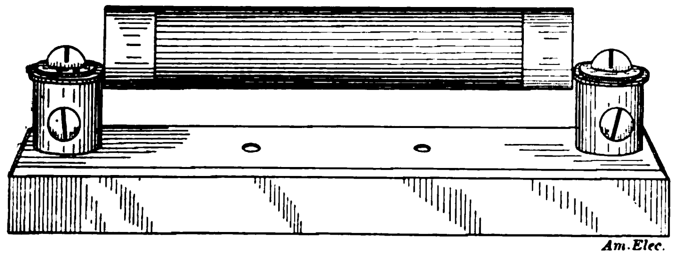
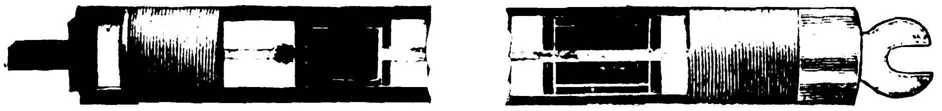


FIG. I.—CUT-OUT COMPLETE.

It has, in fact, broken a short circuit of 220 volts and 375 amperes within a space of ¾ in., leaving the other parts of the fuse-wire whole, and it accomplished this result without any explosion or destructive arc.

A fuse of this type and of 50 amperes capacity has been short-circuited on a 2200-volt alternator within 10 ft. of the dynamo without any extra resistance or shunt in the circuit, and opened the circuit without maintaining an arc between the terminals which were 6½ ins. apart.



FIGS. 2 AND 3.—CUT-OUT BEFORE AND AFTER BLOWING.

In a test made at the Boston Electric Light Company's station before the representatives of the wire department of the City of Boston, and the Factory Mutual Insurance Company, several sizes of fuses were tested on 2140 volts, 500 volts, 104 volts, and all of the fuses operated in a quiet and satisfactory manner.

It has been claimed by a manufacturer of fuses of the enclosed type that the arc is extinguished by the carbonic acid gas generated when the fuse melts. This is an error, as Faraday in his book, ' Experimental Researches in Electricity," says that "In carbonic acid gas there seems to be a facility to occasion spark discharge." This is also proved by the enclosed-arc lamp, in which the arc is maintained within a globe filled with carbonic acid gas.

The growth of the enclosed fuse is quite interesting. A careful search of records of the Patent Office shows that the first patent for an enclosed fuse was issued to T. A. Edison, Oct. 14, 1890.

This device shows a naked fuse-wire within a tube closed at each end, flanges or *disks* on the *outside* of the tube located near the terminals, the fuse, however, being in contact with the case at one or more points within the tube—a device which could not have a constant melting point.

The second patent was issued by D. J. Cartwright, Dec. 2, 1890. This device shows a fuse-wire enclosed within a case closed at each end, with removable partitions located *within* the tube through or around which the fuse-wire passes; a *definite air-space surrounding the fuse*, the case being divided into sections of different lengths and provided with a means for preventing the maintenance of the arc formed between the terminals.

The third patent was issued to G. F. Curtiss, March 31, 1891. This appears to be the same device patented by Mr. Edison, except that the ends of the tube are *open*.

The fourth patent was issued to H. V. Hayes, Sept. 1, 1891. This device shows a fuse enclosed within a *ventilated tube* and a device for indicating the rupture of the fuse when operated on a short circuit, and is now used for the protection of telephone circuits and instruments.

The fifth patent was issued to O. T. Blathy, Aug. 16, 1892. This device shows a fuse-wire enclosed within a case closed at each end, ventilated sides, fixed partitions located within the tube through which the fuse-wire passes, and a *definite air-space surrounding the fuse wire.* In another form he shows an open fuse with movable *disks* at each end.

The sixth patent was issued to J. Sachs, July 3, 1894. This device shows a fuse surrounded by a chemical salt that combines with the metal when heated so that the circuit is opened. Is its carrying capacity lessened when subject to an overload?

The seventh patent was issued to A. H. McCullock, Dec. 3, 1895. This device shows *a fuse loosely surrounded by asbestos* throughout its entire length, the ends re-enforced by the fuse being bent back and twisted around itself in such a manner as to make its central portion of less carrying capacity than the ends, and the whole being placed within a case.

The eighth patent was issued to L. W. Downes, June 2, 1896. This device appears to be a combination of McCullock's fuse, which is surrounded by loose asbestos, with the disks of Edison and Blathy, the perforated ends of Curtiss and the confined body of air of Cartwright and Blathy.

The ninth patent was issued to L. W Downes, Oct. 13, 1896. This device appears to be the same as the patent of June 2, 1896, except that the disks of Edison and Blathy are omitted and a finely divided refractory material in a loose condition is used instead of asbestos, and the definite air-space of Blathy and Cartwright is perforated by many holes.

The tenth patent was issued to W. E. Harrington, April 27, 1897. This device appears to be the fuse of McCullock with the asbestos removed from the central portion, and the center of the fuse in the open air; the ends of the fuse are constructed as shown in Curtiss' patent.

The eleventh patent was issued to D. J. Cartwright, Sept. 28, 1897. This device is an improvement on the device patented Dec. 2, 1890, and appears to be the same except that the ends of the fuse are surrounded by a foreign substance for the purpose of conducting away from that part of the fuse-wire the heat generated by the current passing through the fuse-wire at that point and to absorb the gases produced when the fuse-wire has become broken.

One great advantage of this device is that it may be provided with a means for indicating a break of the fuse wire caused by a short circuit or overload.

The Hunter Alternating-Current Patents.

To the Editor of American Electrician:

I am just in receipt of a copy of your paper of January, and notice on page 24 thereof an article criticising my recent patents of Dec. 21, 1897, which cover broadly the alternating system. Your article, like a great many others which attempt to perform the function of judge and jury on legal questions, walks into many errors, and while no doubt desiring to be just, is led to make many misrepresentations and do a great deal of injustice.

The statements in the first paragraph are not correct, for while my broad patent 596,041 covers the entire art, the second patent 596,042, assigned to the General Electric Company, is sufficiently broad to cover all of the apparatus employing transformers for reducing potential now in use or likely to be used. The first patent mentioned dominates the second and is not owned by the General Electric Company.

You say the other two patents cover "step-up" and "step-down" systems, but in this you are in error, for my patents which cover that special construction and method are 460,071 of Sept. 22, 1891, and 581,684 of Apr. 27, 1897. These patents are issued to the General Electric Company.

Your reference to the work of Faraday, Berliner, Rossetti, Gaulard & Gibbs, and others, is misleading, but will not deceive those who understand the true situation. You may rest assured that these broad patents were not granted to me without the strongest opposition on the part of the Patent Office on the account of the broadness of their scope, but the justness of my position was acceded to, and the Patent Office, which knows more about my work than the writers of articles (who have never known me and do not know anything of my work), is, I think, the better judge of what is due me.

Your reference to me as being widely known as a "paper patent inventor" is one of the idiotic *noms de plume* given to me by those who hate me because I stand in their way in original research. Who originated such a name I do not know and do not care, but in any event it was used in ignorance and only shows the prejudice of the parties using it. No doubt the party would be found to have no acquaintance with me and none whatever with my work. I have seen so much of this that it has no more effect upon me than pouring water on a duck's back.

There is a great deal relating to the alternating system which the public knows nothing about, but will in due time possibly be more enlightened, but they may rest assured that there is more invention in the matters covered by these patents than they would like to believe.

The last paragraph of your article referring to my patents on electric traction, is also another case of an attempt to deprive an inventor of his dues before the public. To this part of your article I would make the following statement: In railway work I have defeated the following parties in numerous interferences (probably fifty or sixty), namely, Van Depoele, Sprague, Knight, Erhart, Wightman, Mansfield, Field, Brill, Bentley, Short, Priest and others. As a matter of fact, the modern car as it is built and used to-day, with every appliance connected with it, from the trolley to the series-multiple controller and trucks, *was built, constructed and operated by me before any one else.* My railway patents are broader in scope than those of any one else, and are justly granted to me. The suits under my broad patents when controlled by the Thomson-Houston Electric Company brought the Edison Company and the Sprague Company to terms and aided largely in the formation of the General Elecric Company. The reason why litigation, has not been largely carried on under my patents is due to the fact that as litigation was started under the Van Depoele patents, common sense dictated that the company owning both sets of patents should confine its litigation to one set until it was necessary to bring in the other set. I object to the insinuations which your article contains, because they are unfair and unjust, and are based upon a misunderstanding and a lack of accurate knowledge upon the real situation, which no one knows better than I.

In conclusion, let me assure you that I am not dead yet and that if I retain my health, my detractors will yet have full opportunity to change their opinions and views, probably to their discomfort, for time usually rights all things.

Philadelphia. R. M. HUNTER.

Electrical Journals.

To the Editor of American Electrician:

Since reading in the January issue of the AMERICAN ELECTRICIAN, that you had been unable to obtain any information concerning the *Telegraphic Journal*, the immediate predecessor of the *Journal of the Telegraph*, I have made a search of contemporary telegraphic literature, and have found the full history of that short-lived publication. It made its first appearance on March 7, 1867, and continued as a weekly until November of the same year, when it was succeeded by the *Journal of the Telegraph*, the first issue of which appeared, as stated in your list, on Dec. 2, 1867, under the editorship of James D. Reid. *The Telegrapher* was the first really successful paper in the United States devoted to the interests of the electric telegraph. It began publication on Sept. 26, 1864, and flourished for thirteen years, first as a monthly, then as a semi-monthly and finally as a weekly as the official organ of the "National Telegraphic Union." The late Franklin L. Pope was at one time its editor. It was in opposition to *The Telegrapher*, which was an independent organ in the days of rival telegraph companies, that the *Telegraphic Journal* was started in 1867, evidently but not openly in the interests of the Western Union Telegraph Company. Eight months later, with a slightly changed name it became the official organ of that company, and has so continued for more than thirty years.

New York. EDWARD CALDWELL.

JACQUES CELL DISCUSSION.

The Jacques Cell.

To the Editor of American Electrician:

In Mr. Reed's last letter he states that I have referred to no facts in support of my contention that the oxygen forced into the Jacques cell takes part in the electro-chemical reaction. I have repeatedly stated that the current is greatly increased by the introduction of oxygen. In my own experiments it, in fact, becomes *at once* about three times as great, when oxygen is introduced. When the gas flows slowly, 15 or 20 bubbles per minute, the needle of the ammeter swings from 1 to 3 amperes with every bubble. This last fact, I think, I have not before mentioned. I have also stated that more oxygen is *absorbed* by the cell when the circuit is closed than when it is open. This I demonstrated by adjusting the flow to give 60 bubbles per minute with circuit open. When circuit was closed this was reduced at once to 40. The change in rate was very marked, was perfectly evident without counting, and occurred every time the circuit was opened or closed. These are facts which seem, to others than Mr. Reed, to have a bearing upon the question at issue.

Mr. Reed says my analogies are not analogies, and makes some surprising statements in relation to the action of a couple in dilute acid. Surprising because they are contrary to all accepted beliefs. He says that agitation of a copper electrode in a zinc-copper cell, or the flow of an inert gas over it, mechanically removing the bubbles of hydrogen, will have the same effect as introducing oxygen.

These are the facts. If a zinc-copper couple be put on closed circuit through a small resistance for a few minutes it will gradually recover its E. M. F. on opening the circuit by shaking or even if left to itself. But if an inert gas be run through a closed cell so as to displace all oxygen and then the circuit be closed for intervals of an hour or so, it will take a longer and longer time after each interval for the recovery, until, in my experiments, after ten or twelve intervals of an hour each, the cell only recovered very slightly after standing open for an hour. It was violently agitated. Hydrogen gas was run rapidly through it. Nitrogen was substituted for the hydrogen. None of these had any sensible effect, although my instruments would have given a marked indication for a variation of $\frac{1}{10000}$ volt. Oxygen was then substituted for the nitrogen. The index at once shot off the scale, and as soon as a balance could be obtained, which required not more than fifteen seconds, the cell was found to have completely recovered, its E. M. F. having increased in that interval from .58 to 1.04 volts, while in the previous hour with all the shaking and treatment with inert gases, it had risen only from .52 to .58.

After the E. M. F. is restored by running oxygen through it, the cell must be left on closed circuit for several hours, the air at the same time being displaced from it by an inert gas, before it will again be in a condition not to recover its E. M. F. on opening the circuit.

Again, the circuit was closed through a resistance less than the internal resistance of the cell. The potential difference between its terminals was measured and found to be .214 volt. Hydrogen was then run through the cell slowly, rapidly, stopped, started again, without apparent effect, except that when the gas flowed very rapidly the E. M. F. was $\frac{2}{1000}$ or $\frac{3}{1000}$ *less.* Oxygen was then substituted and the potential difference at once increased, reaching .348 volt when the flow was quite rapid. This meant an increase of E. M. F. due to the oxygen flowing through the cell, from .52 to .827 volt, with a corresponding increase in the current.

The results attained were entirely similar when a zinc-carbon cell was used except that carbon gives a somewhat higher E. M. F. than copper.

I may say that, in my experiments, the liquid was a $\frac{1}{10}$ solution of pure H_2SO_4 in distilled water, and that the two electrodes were in separate porous cups set in a bottle and surrounded by a considerable volume of the electrolyte. The copper electrode was a tube through which the gases were introduced. I have recently verified these results, but they are in entire accord with the views I have derived from the literature of the subject within the last ten or twenty years.

They effectually dispose of Mr. Reed's statement that shaking the electrode, or running an inert gas through the cell, will have the same effect as oxygen. They demonstrate that oxygen gas conveyed into a cell *does* act as a depolarizer, does act to increase the current, while an inert gas does not. Oxygen gas conveyed into the Jacques cell increases the current three to one. The ammeter in circuit with the Jacques cell indicates the instant that the flow is started or cut-off. Where is the lack of analogy?

Mr. Reed says that when a platinum plate is used, the oxygen combines with it. This is not an accepted fact. The view generally held is that oxygen is condensed upon the surface, not absorbed into the plate even.

I repeat here what I have already said many times. For the oxygen to take part in the development of electrical energy in the Jacques or any other galvanic cell, it is only necessary that it *come into electrical contact with the cathode.* This it may do by entering into combination, by going into solution, by being condensed upon the surface of the electrode, by being absorbed by the electrode. In fact some of my experiments seem to indicate that merely damp oxygen in the gaseous form may so act.

It is absolutely certain that in the Jacques cell it does come into electrical contact, otherwise the current would not instantly respond to the flow of oxygen, and the absorption of oxygen would not at once vary with the opening and closing of the circuit.

Mr. Reed asks me to explain the "fact" that two iron electrodes, one hot and the other cold, maintain an E. M. F. of 1.2 volts "indefinitely, so long as the temperature is maintained." Will they?

The German experimenters, to whose work I have already referred in these letters, showed that the E. M. F. depends upon the oxidation going in at the surface of the electrolyte and that it is *not* maintained indefinitely. I expect before long to have some results of my own to present, bearing upon this matter. **Wm. A. Anthony.**

Cooper Union, New York.

On the Theory of the Jacques Cell.

To the Editor of American Electrician:

You have asked my opinion concerning the views advanced in a number of articles in the columns of the AMERICAN ELECTRICIAN, on the theory of the so-called thermo-electric cell constructed by Archereau and Jacques.

This cell consists, as is well known, of a vessel of iron, in which hydrate of sodium is kept in a state of fusion at a temperature of 400 to 500 degs, C., and in which a rod of carbon is dipped. As soon as the iron vessel and the carbon are connected by a conductor, and atmospheric air is forced through the fused hydrate, an electric current is set up, and this will continue, according to the connections made, as long as the air is forced through the hydrate, but stops when the supply of air ceases.

The chemical process which takes place in this cell is the following: The carbon is oxidized to carbonic acid, which combines with the sodium hydrate, while the iron does not seem to be acted upon. The question is now, What is the source of the electric energy in the cell? Some are of the opinion that the battery should be considered as thermo-electrical, and consequently that the energy is produced by the heat added to it; while others maintain that the source of the electric current is the energy which is set free by the chemical process, and that the battery, consequently, should be classed with ordinary galvanic batteries.

Unfortunately, as far as known, no measurements have been made regarding the consumption of carbon and oxygen in the cell compared to the electric energy produced; such measurements would have served to decide the question immediately. Nevertheless, I am inclined to express it as my opinion, that the source of the electric current should be looked for in the heat set free by the chemical process.

The different materials in reaction are carbon, hydrate of sodium and oxygen, and the products are carbonate of soda and water. The total amount of energy, W, which is set free by the process is, as it will be remembered, independent of the manner in which the process is carried out, and can be expressed by the formula

$$C + 2\,NaOH + O_2 = Na_2\,CO_3 + H_2O + W.$$

According to my measurements,[1] the heat of formation of $2\,NaOH$ from its elements is 203740 calories, and for H_2O we have 68360c. Further, the reaction Na_2, O, CO_2 produces[2] 175,680c. As the heat of combustion of artificial graphite (retort carbon) according to the measurements of Favre[3] is 93,140c for 12 grammes of carbon, the heat of formation for Na_2CO_3 will be 268,820c, and we will, according to the formula, have

$$W = 268,820\,c + 68,360\,c - 203,740\,c = 133.440\,c.$$

These figures are, of course, not correct except at a temperature of about 18° $C.$, but the differences at a higher temperature will partly balance each other, and the value of W will therefore be correct to a sufficient approximation.

In order, now, to determine how much of the total energy can be changed into electrical energy, it is necessary to examine more closely into the process of oxidation of the carbon. There are three possibilities: 1°. The oxygen may combine direct with the carbon. 2°. The oxygen may form oxide of iron, which is again reduced by the electric current. 3°. The oxygen may be occluded by the iron or by the hydrate of sodium before the reaction of the carbon takes place.

1°. To my knowledge no decided instances are known where heat, produced by direct combination of two elements, is changed into an electric current. It is required, in order to transform energy produced by a chemical process into electric energy, that the two agents between which the chemical process takes place, should be separated by two other bodies, of which one should be a direct and the other an electrolytic conductor[4].

2°. If the oxygen is first united with the iron in chemical combination, the whole energy will be heat and no electric energy will be produced. And as the heat liberated by the oxidation of iron is 68,280 c. for each atom of oxygen, the heat produced by the oxidation of the carbon and the reaction of the carbonic acid on the hydrate of sodium will hardly compensate for the heat required for the separation of oxide of iron, and there is consequently no chemical energy left which could be transformed into electrical energy.

3°. It is, therefore, reasonable to believe that the oxygen which is brought into the cell, is to a certain degree occluded by the iron (direct, or supported by the hydrate of soda), in a manner similar to that in which oxygen and hydrogen are occluded by the platinum plates in the Grove (gas) cell, before they act as a factor in the production of electric energy. By such occlusion heat is produced, and this should be deducted from the total heat produced by the chemical reaction, in order to find out how much of this heat can be transformed into electric energy. According to measurements[5] by W. Ramsay, L. Maud and J. Shields, the heat of occlusion by platinum of 1 atom of oxygen (16 grammes) is 17,600 c. If it should be the same for iron, which has many qualities in common with platinum—and it seems to me reasonable to suppose that it will be near it—we will, if the heat of the occlusion is x, have as the whole energy, which can be transformed into electricity

$$W' = W - 2\,x = 133.440\,c - 35,200\,c$$
$$W' = 98,240\,c$$

or for 1 atom of oxygen absorbed there are 49,120 calories.

In the Daniell cell the energy which is transformed into electric energy is 50,130c for each atom of oxygen or zinc[6]. If the E. M. F. of this element is 1.090 volts, 46,000 c will correspond to 1 volt, and consequently we will, if all these 49,120 c are transformed into electric energy, find the E. M. F. of the Jacques cell to be

$$E = \frac{49120}{46000} = 1.07 \text{ volts.}$$

Should the heat of occlusion of the oxygen be less than 17,600 c, E will be larger; and should it be zero, E would be 1.45 volts. Between these two numbers, and most probable nearer the lowest, will the E. M. F. of the Jacques cell lay. This corresponds well with what J. H. Hellurg, Jr.,[7] has found, 1.11 volt; if the heat of occlusion of oxygen in iron should be 15,660 c, it being 17,600c for platinum, E would be exactly 1.1 volt.

In view of the above, I am of the opinion that the process in the Jacques cell is as follows: The oxygen introduced into the cell is occluded by the iron, and the whole apparatus has thus the same character as the galvanic cell; the electric current produced will, as usual, decompose the water in the hydrate of sodium, the oxygen will go to the carbon, the hydrogen to the iron, where it will combine with the occluded oxygen, and the result of this reaction will give an E. M. F. very near to 1.1 volt.

I am not inclined to think that this apparatus, which is difficult to work and expensive to keep in active condition, will be of practical value as a producer of electricity.

Julius Thomsen.

Copenhagen, Denmark.

Kilowatts and Microwatts.

A western newspaper prints a glowing account of the achievement of a local "Wizard" who has built an "electromotive machine weighing less than 50 lbs. that has a power of 100,000,000 microwatts"—that is about an eighth of a horse power. The local wizard apparently could see no harm in carrying out to its logical consequences an occasional commercial custom of expressing in watts, capacities whose proper expression is in kilowatts.

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[1] See Thomsen's "Thermochem. Untersuchungen" III, p 232.

[2] Ibidem, p. 520.

[3] Ann. Chim. and Phys. (3) XXXIV, 424.

[4] See "Thermochem. Untersuchungen," p. 480.

[5] Phil. Trans. of the Royal Soc. of London, Ser. A, Vol. 190, p. 151.

[6] "Thermochem. Untersuchungen" III, p. 493.

[7] American Electrician Oct., 1897, p. 392.

NORTHWESTERN ELECTRICAL ASSOCIATION

One of the most interesting conventions ever held by the Northwestern Electrical Association convened at the Hotel Pfister, Milwaukee, Wis., January 19th, being the sixth annual meeting of this association. In point of numbers, this meeting was the largest ever held, nearly 175 delegates being present. The supply men were well represented, the Chicago delegation alone comprising nearly 60 members.

The report of Secretary Mercien showed the association to be in a very flourishing condition, and over 50 new members were added to the rolls at this meeting.

Of the papers read, those by Mr. Alex. Dow, Prof. R. B. Owens and Mr. W. H. Edgar excited particular interest, that of Mr. Dow leading to a prolonged discussion.

Among the reports of committees was one by Mr. Pliny Norcross on "Legislation." Mr. Norcross stated that at Madison, during the session of the Legislature in 1897, some of the interests fearing adverse legislation were strongly represented. The gas interest and water companies were very strongly represented. Street railway companies, insufficiently so and the central station interests exhibited still less strength than the last named. Mr. Norcross stated that his committee was handicapped by lack of knowledge as to the views of the electric lighting companies of the State on questions that came up, and regrets the lack of organization of the electric lighting interests. As it was, his committee succeeded in defeating or amending certain bills that were thought to be antagonistic, and Mr. Norcross hoped that the association at this meeting would outline some clear plan for future guidance.

In his presidential address, Mr. H. C. Higgins spoke highly of the value of associations and frequent conventions to the members and attendants. He stated that it is gratifying to know that the hard times have been bridged over, and that we are now on the eve of better times. No company represented in the association had gone into the hands of a receiver within the past year except one, and that only temporarily, while there has been no state legislation enacted particularly offensive to the electric lighting business. Mr. Higgins considers that the greatest danger to the electric lighting business is from inventive genius, which he believes may any day destroy their investments.

The street railway business, he thinks, has suffered more during the past two years than any other legitimate business, notwithstanding that the expense of operation and cost of apparatus and material has been very much reduced. He, however, looks forward to the future of this business with much hope. As the result of a considerable experience, he advises that not less than a 60-pound steel T rail be used, with good ties, not less than 6 inches wide, laid with two feet between centres, still closer being better. In bonding, not less than No. 0 bond should be used and nothing less than No. 0 trolley wire. Nothing larger than 16 to 20 feet cars should be bought for general use, and no mistake can be made in buying the latest types of generators and equipment. Extra lines should not be laid out in order to establish a park, unless the latter is on the edge of a body of water and the road in a town of not less than 30,000 people. No animals should be purchased for the park, and vaudeville or other shows should not be run unless the situation is such that transportation would cost but little. Street railway parks should be well enclosed, and no one admitted without paying car fare each way, no matter whether they come by carriage or bicycle. Mr. Higgins does not believe that any town of less than 25,000 people will support an electric railway and give a decent return to its investors, although two towns aggregating a little less than that population, and being some distance apart, might support a good paying property. Mr. Higgins considers that the electric railway business is also menaced by inventive genius, which may at any moment render electric railway investments valueless.

The following officers were elected for the ensuing year:

President, F. A. Copeland, La Crosse, Wis.; Vice-Presidents, James R. Dee, Houghton, Mich. and P. H. Korst, Racine, Wis.; Secy. and Treas., Thomas R. Mercien, Milwaukee, Wis.; Directors, E. L. Debell, Sheboygan, Wis.; George L. Thayer, Belle Plain, Ia.; and S. B. Livermore, Winona, Minn.

THE PRACTICE OF THEORY.

Mr. John C. McMynn read a paper having for its object to show the close relations existing between the theoretical man and the practical engineer. He said that he firmly believes, after mature observation, that the educated engineer who can master practice as well as theory, is the one who will rise above his competitors in the future. By "educated," however, is meant not necessarily a college graduate, but also the man who can master the laws of mechanics and can conquer mathematics by his own exertion. As a good example of the application of theory, a recent invention is referred to which consists in pumping water into a closed tank at an elevation above the water level of a boiler, from which tank the water flows into the boiler by gravity; the head against which the pump has to work may therefore only be 20 feet, instead of perhaps a 200 ft. head; thus entailing a saving of about 85 per cent of the steam formerly used by the boiler pump.

THE PRESENT EFFICIENCY OF INCANDESCENT LAMPS.

In a paper with the above title, Mr. John E. Randall gave a sketch of the incandescent lamp art to date and concludes that at present the best efficiency for central stations lies somewhere between 3 and 3¾ watts per c. p. The present incandescent lamp owes its good qualities, he said, to the use of cellulose filament.

Referring to the vacuum of lamps, Mr. Randall considers that after a vacuum of one part in ten thousand is reached, the loss of heat through convection is negligable, and that the degree of exhaustion ordinarily found in the incandescent lamp is better than need be, so far as this loss is concerned. A high degree of exhaustion is not the main object to be obtained, an unchanging vacuum being the essential point with respect to the maintenance of the highest brilliancy. If a lamp is properly made and exhausted in the first place, absolutely no leak can be detected after usage. In some cases where used for at least twelve years, in rheostats where the current at times brought them to full brilliancy, the vacuum of lamps has been found as good as when first made.

In purity, density, surface polish and uniformity, which are the features that determine quality and maintain efficiency, the cellulose filament, properly made, far exceeds any other kind. A graphitic coating on an amorphous carbon body in a vacuum is, so far as known, the best combination for fulfilling these conditions. The use of cellulose has also made the 220 volt lamp a commercial possibility. Recent lamps, he said, are approaching the ideal lamp which, when its work is done, breaks and thus announces its own smashing point.

The results of tests on three classes of lamps—110 volt cellulose, 110 volt untreated bamboo and 50 volt treated bamboo—are given, the initial watts per candle power being 3.2 for each. At the end of 600 hours the candle power of the first mentioned lamp was 14.96 and the watts 3.54; of the second mentioned lamp, 9.9 and 4.75; and of the third lamp 14 and 3.67.

The writer stated that one of the largest alternating stations in the country has, by substituting the highly efficient cellulose lamp for the low economy silk and bamboo lamps, and by improving its regulation, been able not only to reduce the price of service to its customers, but to increase its lamp capacity over 25 per cent. There is one condition which must be fulfilled in order that incandescent lighting may be more profitable—the voltage at the lamps must be kept everlastingly and unceasingly steady. There has been some improvement in this respect but much is yet necessary and desirable.

PHYSICAL AND CHEMICAL PROPERTIES OF VOLATILE OILS IN BOILERS.

Mr. W. H. Edgar spoke on the ill effects of using volatile hydro-carbon oils in boilers, and gave a clear and concise theory of the proper methods of preventing incrustation. Referring to the use of kerosene pumped into the steam boiler with the object of converting the incrustation into such form as to readily wash out, or preventing its formation, he says that its effect is purely mechanical, there being no chemical reaction whatever. The kerosene penetrates the scale and softens it by running between the scale and the iron, and when the boilers are shut down, loosens it and thus renders its removal more easy. A disadvantage from the use of kerosene is that if it distills over, it forms a series of oxidizing hydro carbons, which will intensify pitting and grooving, eat through flanges, and destroy thread connections; it passes, besides, into the cylinder, dilutes the lubricating cylinder oil, blackens the piston rods, has a deleterious oxidizing effect on the piston rings and on metallic packing, if this latter be used. In addition, that part of the oil which goes through the scale and reaches a surface at high temperature, is carbonized, which results in the carbonization of the iron and the appearance of a blistered spot.

In answer to a question, Mr. Edgar stated that the corrosion from condensed water is purely an oxidation with the aid of hydrogen, ferric hydrate being formed, which may subsequently be converted into an oxide. Speaking of vegetable compounds, he said that sugars and tannins (but not tannic acid), may be used, the latter taking care of the carbonates of lime and magnesia. Sugar introduced in the steam boiler will convert the sulphates into saccharates, the latter breaking up into oxalates, tartrates and carbonates, and, in the presence of tannin extracts, into the tannate of lime, so that but a small proportion of sugar is necessary in the general mixture to handle a water containing both the sulphates and the carbonates, the components to be proportioned according to the impurities found by analysis in a given water. It is well to also mix in a little slippery elm, poke root or powdered willow hard wood pulp, so as to get a little soluble starch to keep the sugars and the tannins from being too stable.

In conclusion, Mr. Edgar stated that under no circumstances should kerosene oil or caustic soda be used in boilers. A surface blow-off contrivance is good if intelligently used. Finally, he advises the steam user to have the water analyzed and then go to the wholesale druggist to have the tannin and sugars mixed in proper proportions, and the boilers should be dosed regularly.

TOPICS OF INTEREST TO CENTRAL STATION MEN.

Lieut. F. B. Badt delivered an address on the above mentioned subject. Taking up the old question of alternating vs. direct currents. Mr. Badt thinks it is now the universal opinion of engineers and such managers of central stations as have had an experience in the matter, that where the conditions are favorable to the direct current system, it has many advantages over the alternating system; but that in certain cases an alternating current system must be installed where long distances ate involved. The 220-volt direct current system was referred to in high terms. It is much more easily managed by the three-wire system, costs less to install and less to maintain. To-day good 220-volt incandescent lamps can be procured, and also an enclosed arc lamp burning singly across a 220-volt circuit. As 220-volt direct current motors have many advantages over a 110-volt motor, the 220-volt system is a good one in all respects for small central stations where distances of, say, less than ¾ of a mile radius from the station are made. The 220-volt arc lamp uses 2½ amperes with 160 volts at the arc, to produce a nominal candle power of 2,000, the arc being ¾ of an inch long.

Where there is an elevator service the 220-volt system has a great advantage in that great fluctuations of the power circuit will not be noticeable in the arc, which will practically not be affected by a variation in the power circuit of, say, 50 volts. Lieut. Badt considers that it will not be very long before we will have an enclosed arc of 500 volts for use on 500-volt railway circuits. It is suggested that, owing to the diversity in the diameters of the opening in the gas cap of enclosed arc lamps, which may lead to considerable trouble to those who buy carbons indiscriminately, this diameter should be standardized, and he suggests that it would be desirable for the Association to use its influence to that end.

Lieut. Badt considers that the single phase alternating current system will eventually be regarded superior to polyphase systems, owing to its simplicity, and he thinks that it will not be long before there will be any number of different makes of single phase motors on the market. The use of large transformers serving a number of customers is advocated, it being recommended to use one transformer, if possible, for a block, the block to be wired on the 220-volt system for 220-volt lamps and motors. The steam engine was referred to, Lieut. Badt saying that in the best type the efficiency is only 13 per cent, there being thus 87 per cent left for improvement; and this efficiency is compared to that of the dynamo where manufacturers guarantee as high as 95 or 96 per cent. The Diesel gas engine was spoken of in very high terms, Lieut. Badt believing that it will be the heat engine of the future.

ELECTRICITY IN MUNICIPAL ENGINEERING.

Prof. R. B. Owens presented a paper with the above title, the object of which, he stated, was to emphasize the economy which can often be effected by generating at one point all the power required by a municipality and distributing it for whatever purpose by electrical means. In small towns where a supply of water is obtained from driven wells, power pumps may be used, obtaining power through a counter shaft from an engine of economical design, one or more dynamos being attached to the same counter shaft. If both dynamos and pumps are driven by clutch pulleys, it is possible by shutting down pumps as the dynamos are started, and varying the number in operation as the lighting load varies, to keep an almost exact constant load on the engine. In larger towns, where it is not unusual to find half a dozen pumping stations from a half to a mile or more apart, triplex power pumps, operated by constant torque speed motors, may be substituted, the current for such motors to come from a central power plant equipped with economical machinery and suitably located; this arrangement, it was estimated, would give in a certain town that has been under consideration, a saving of more than 50 per cent in the total cost of operation. A suitable reservoir should always be supplied so as to allow the engine or engines to operate at a constant load, and also to supply extra water for fire purposes whenever required.

Prof. Owens considers that no system of sewerage is complete which does not abstract the solid matter and sterilize the liquid portion before turning it into water ways. In the disinfection of sewage it would seem that electrical methods must supersede chemical ones in the future. In the electrical system the disinfection is obtained by passing a large current of electricity at low voltage through sea or salt water, prior to or after being mixed with the sewage, which results in the disinfection of the latter. An important point in this connection is that the electrical system implies a high efficiency of operation, for the reason that a current would be used at a practically uniform rate, thus fitting in very perfectly with the economic operation of a pumping plant, and the requirements of a plant to burn and utilize town refuse.

The calorific value of town refuse, which is about one-fifth that of coal, should be utilized, and as it requires to be burned at a very regular rate during the 24 hours, electrical energy generated therefrom will be suitable for use in pumping and for the electrical purification of sewage, the demands of power for these purposes being practically constant.

Referring to a thermal storage in connection with lighting plants, a scheme is proposed in which, instead of using separate thermal storage tanks, by carefully lagging the entire boiler setting and providing removable non-inductive covers for the fire and ashpit tools, the boilers themselves may be converted into heat reservoirs.

When one boiler or battery is put out of service, the steam generated by the remaining fire on the grate and by the heat absorbed by the setting will, when it exceeds by a certain amount the pressure in the main steam pipe, pass into the latter through a reducing valve. When the boiler is to be put in operation again, it has a pressure equal, or perhaps greater than that of the service, in the latter case immediately aiding by its volume of stored energy, to supply the demand for steam. By providing an arrangement for starting fires with oil when necessary, the standing-by boilers in a battery can be put into full operation at the rate of perhaps one a minute.

Prof. Owens referred to the fact that in Great Britain, ashbin refuse is burned in destructors in more than 50 towns, in many cases the heat therefrom being utilized in the generation of steam. In most cases a combined plant can be designed to burn and utilize the ash bin refuse in the pumping of water from a series of scattered wells, and supply current for street lighting and sewage disinfection, the arrangement being such that all the machinery will be loaded very nearly to full capacity 24 hours a day.

MUNICIPAL SOCIALISM.

Mr. Fred DeLand, in a paper with the above title, dealt with the subject of municipal ownership, taking its operation in the City of Des Moines, Ia., and several other cities as examples. In the first mentioned city an attempt to start a municipal plant was prevented, temporarily at least, by an injunction, whereupon the Mayor, upon the expiration of the lighting contract, refused to pay more than $75 per year per lamp. $126 having previously been paid. Mr. DeLand shows that even under the figures given as to the cost of lighting from the proposed municipal plant, the cost would be $76. The last official report of the cost of street lighting in Detroit was $89.42 per lamp. In Allegheny City, Pa., the cost of operating arc lamps from a municipal plant is $74.32 and the official in charge of the plant stated that a fair price for commercial companies, under the conditions of that city, would be $80 per year with coal at $1.00 per ton; $90. with coal at $2.00 per ton; and $100 with coal at $3.00 per ton. Topeka, Kan., paid during the first six years of municipal ownership, when machinery, circuits and lamps were in good condition, $93 per year for each arc lamp used in street lighting, not taking into consideration the extra investment necessary to replace old machinery, the risk that attends all enterprises of like character, loss of water rates, taxes, etc. The average cost for Detroit, Topeka and Allegheny City is therfore $85 per lamp under municipal operation, and in view of the statement of the mangement of the plant in the latter place, that where good steaming coal costs $1.00 per ton, $80 is a fair price for commercial companies to charge for street lights of 2,000 c. p., burning all night and every night, Mr. De Land considers that the action of the Mayor of Des Moines in only allowing $75 per light is simply a political stroke to gain the applause of unthinking voters.

In the discussion on Mr. DeLand's paper, it was stated that in an official report of the Mayor of Des Moines, the cost of lighting in Topeka was given at only $40 per year, whereas a proper analysis shows the actual cost at $93 per lamp, without taking into account depreciation.

Mr. Doherty stated that some time ago a total depreciation on electric plant was figured at 8.3 per cent, based upon information obtained from competent authority. He stated that even on a depreciation of 5 per cent the cost of lighting from the Detroit plant amounts to $105 per year per lamp.

Prof. Jackson expressed the opinion that in a plant put up in the best manner, in a town of from 20,000 to 100,000 inhabitants, the depreciation is not less than 7½ per cent per year, and he doubts if there are many plants that have a right to write off less than 10 or 15 per cent. He added that these figures did not take into consideration changes in market value; that is, the market value of material is assumed the same at the end of a given period, as when the plant was constructed.

Mr. Thayer gave some data concerning the cost of lighting in some towns where he had made investigations. At Vinton, Ia., he found that the cost of a 32 c. p. lamp on a street is about $13 per year, the plant being a municipal one. At Lisbon, the cost of arc lights from a municipal plant is over $100 per year. Mr. Pierce stated that the City of Negaunee has been assured, when considering the subject of a municipal plant, that 35 arc lamps and 1,000 incandescent lamps could be run on less than a ton of coal per day. He said that the plant had now been running less than four months and had already burned the year's supply of coal, based on the above estimate. He added that the estimate for putting in the plant was $10,000, that the bid of the successful company was $9,904, but the extras, etc., have brought the price close to $18,000, and the plant is not yet finished. A 16 c. p. light is furnished for 13 cents a month from this plant. Mr. Trott related an experience which the citizens of Holland, Mich., have had with their plant. The initial investment has been exceeded many times, the prices of the lights have been raised 50 per cent and the plant is still running behind.

Mr. Bean stated that he had been informed by a lawyer of Grand Ledge, Mich., that they were running from their municipal plant 2,000 c. p. lamps at a cost of one cent a night, but upon investigation he found that the lamps cost $10 per month. The chairman of the board of works, however, informed him that they had been charging $5 per month for arc lights, but were going to cut that price to $2.50!

ELECTRIC LIGHTING FOR PROFIT.

Mr. Alex. Dow, in a paper with the above title, maintained that the proper policy of electric light management under the conditions of the present time, is to sell electric energy to every accessible user in any shape that the user requires, and at the lowest price that will pay a reasonable profit on the capital invested. The evil effects of the former policy of operating under "systems" was referred to, one of the results being that unduly high prices had to be charged for the product sold to customers, which led to the growth of municipal plants.

As to what is reasonable profit, Mr. Dow believes that after operating expenses are paid and any deterioration of the investment shown by a carefully made inventory has been made good, a dividend such as is paid by a good manufacturing business is reasonable for electric lighting. The amount of this dividend will depend upon circumstances, as in other lines of business. A well established station, with no ruinous competition to meet, and not threatened by municipal interference, nor obliged to continually risk money in extensions of uncertain character, may pay a dividend but little in excess of the current rate of interest paid by savings banks. On the other hand, the station in which all these conditions are reversed, is entitled to a greater return.

Unfairness of municipal lighting advocates is pointed out. A man who thinks it no harm that he should draw from the capital invested in his own business 10 or 15 or 20 per cent, in addition to a fair salary for management and any loss that is shown by annual inventory, and who thinks it entirely proper that he should build up a business worth much more than its normal capital by turning into it a large surplus, may nevertheless denounce a private electric lighting company which pays a good deal less than 10 per cent, which he refuses to assist in protecting from unlimited competition, though demanding that it does business for a rate of profit accepted only on the safest class of investment bonds.

The method of analysis of station costs, introduced by Mr. Arthur Wright, by means of which to arrive at a rational system of rate making, is highly spoken of; but Mr. Dow considers that as American conditions usually differ from those existing at Brighton, it is seldom possible to apply the short method of estimating standing and running cost which Mr. Wright finds convenient, and an analysis in detail must be made.

The method used by Mr. Dow involves a consideration of what the condition of the situation would be if one were obliged to be ready to do the same business now being done and during the same time, but with no customers taking current. The rule is to ask whether any item of expense will continue or would cease under the conditions described. If it would continue, it is a standing charge; if it would cease, it is a running charge. It is clear that taxes, insurance and interest are also standing charges. Account should also be taken of a customer's load factor. Mr. Dow says that by using Mr. Wright's Niagara paper as a text book, others will find, as he did, that the labor is well paid for by the results which will follow carrying out its indications. His anaylsis showed that he could afford to sell current to a large class of users at 4½ cents per unit, while at a rate already established of 14.4 cents, another large class was unprofitable. He states that he is now taking all the 4½ cents business he can find, and letting other people hunt for the 14.4 cents kind.

Mr. Dow recommends working up a motor load, as there is in nearly every village some demand for power, and even if the rates are very low, they will pay the additional cost of running the station during the day time, and also carry some proportion of the standing charges.

The only way to do residence lighting at a profit is to do all the lighting, or nearly all, that there is in a given residence district, and for this reason the rate must be placed so that every posible customer can afford it. Mr. Dow has tried the experiment of low residence rates, and in each instance with success. He adds that the load factor of residence lighting is much better than the average load factor of many stations. Mr. Dow says that to design a new station on any other than a general distribution system, furnishing incandescent and arc lights and electric power from the same dynamos and the same mains, is almost criminal.

A proposition that a lighting station should furnish street railway current should be dealt with as involving a new investment, always the cost of a dynamo and switchboard, and usually the cost of an engine. Furnishing street railway current appears to be equivalent to the sale of steam to a special engine and the furnishing of attendants to additional engines and dynamos; and it should be considered as a business proposition on that basis and not in the same manner as a demand for current from the electric lighting plant.

If a street lighting contract can be taken without investment in special machinery, it may be done at a very narrow margin of profit; but when an investment is required in special machinery and the building of special lines, such a contract is usually undesirable business. This follows from the reason that city contracts are usually short, and there is no security as to their renewal. A good educational work would be to make clear to the people that the price for a year's street lighting depends upon whether the street lighting plant would be employed next year or would be standing idle, as a company might have some chance to make close bids for a long contract without feeling that it was engaged in a risky speculation.

Among special sources of revenue mentioned is the employment of a lighting plant in work not usually considered as part of the lighting business, such as involved in an arrangement with a manufacturer whereby machinery required by the plant during evening hours will be used by the manufacturer in the day time, and the sale of exhaust steam for heating purposes. An arrangement can be made in some places for the joint use of water power.

As to the question: How can business be held when once obtained?, Mr. Dow states that the whole law and gospel consists in getting customers to believe that they receive good value for their money, and to convince them you must yourself know in your own mind that you really are giving good value. To this end it is essential that the central station manager shall know what each block of lighting costs, and he should use every opportunity to keep his customers satisfied, though this latter requirement may mean that a man has to idle at times around the station waiting for trouble calls. Mr. Dow summed up his paper as follows:

(1) The electric lighting business should pay a reasonable profit, approximately the same rate as any manufacturing business which has similar risks. This profit should be paid after the expenses of operation, maintenance, and depreciation shown by annual inventory have been provided for. (2) Rates for electric supply should be so adjusted that each unit sold will pay its share of operating and standing charges, and in addition thereto a uniform proportion towards profit. No business should be done at a loss and no business should pay more towards profit than its proper share. (3) Every class of business that can be profitably done should be obtained. Business that improves the load factor should be taken if it can be obtained at any price greater than its share of operating and standing charges, because the improvement of the load factor reduces the amount of standing charges to be borne by existing load. (4) Business once obtained should be kept by careful study of, and prompt attention to the requirements of each customer. It is not possible in the present stage of electric development for an American electricity supply company to limit its interest in the supply to its delivery to the customer's premises. It must do much work in order to secure that the customer uses the supply to the best advantage. It is not sufficient that a customer should be well served; he must also be well pleased. (5) There is need of educational work to be done among electric light men, among municipal authorities and municipal theorists, and among our own customers. It is our interest that this educational work should be done, and as it does not appear to be the duty of any other person to do the work, we will have to do it ourselves.

In a discussion of Mr. Dow's paper a question having been asked concerning the installation of a power circuit in connection with a combined alternating and direct current plant, Mr. Dow said that a person who had such a plant is unfortunate, and that a selling agent or consulting engineer who would recommend such a plant is almost criminal.

In establishing a new plant or reorganizing an old one, Mr. Dow said that the monocyclic system is a good one, and very satisfactory for the general class of country towns and attendants; he considers it a mistake, however, to put in 2,200 volts if a little more copper will let one out with 1,100 volts. The 220-volt system is also excellent for the above conditions, and will answer for most of the small towns.

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HORSE POWER OF WATER-WHEELS AND TURBINES.

BY PROF. OLIN H. LANDRETH.

The accompanying diagram is for the graphical determination of the HP of any given waterfall, being a simple form for the graphical reading off of the HP from the formula, $HP = \frac{HQDE}{550}$, in which H is the effective head on the wheel in feet; Q, is the quantity of water flowing in cubic feet per second; D, is weight of water per cubic foot, and E, is the percentage of efficiency of the wheel.

For $D = 62.4$ lbs. per cubic foot, $HP = 0.1134\ HQE$.

The inclined lines radiating from the zero at the lower left corner are of three different kinds: Those running to the upper edge of the diagram represent the quantity of water; those running to the right side of the diagram represent the different percentages of efficiency, except the one line which crosses the margin between 85 per cent. and 90 per cent., which is a conversion line to transform the resulting value of the HP into such linear values as to permit them to be represented by the graduations along the base of the diagram. This line is drawn at an angle with the vertical lines, whose tangent $t = \frac{1}{2}(0.1134)\,75 \cdot \frac{v}{h}$ where v and h are the numerical values of the vertical scale of head and the horizontal scale of quantity; the ½ being introduced in this side to make the HP units along the case of the diagram one-half the value of the quantity units along the top of the diagram.

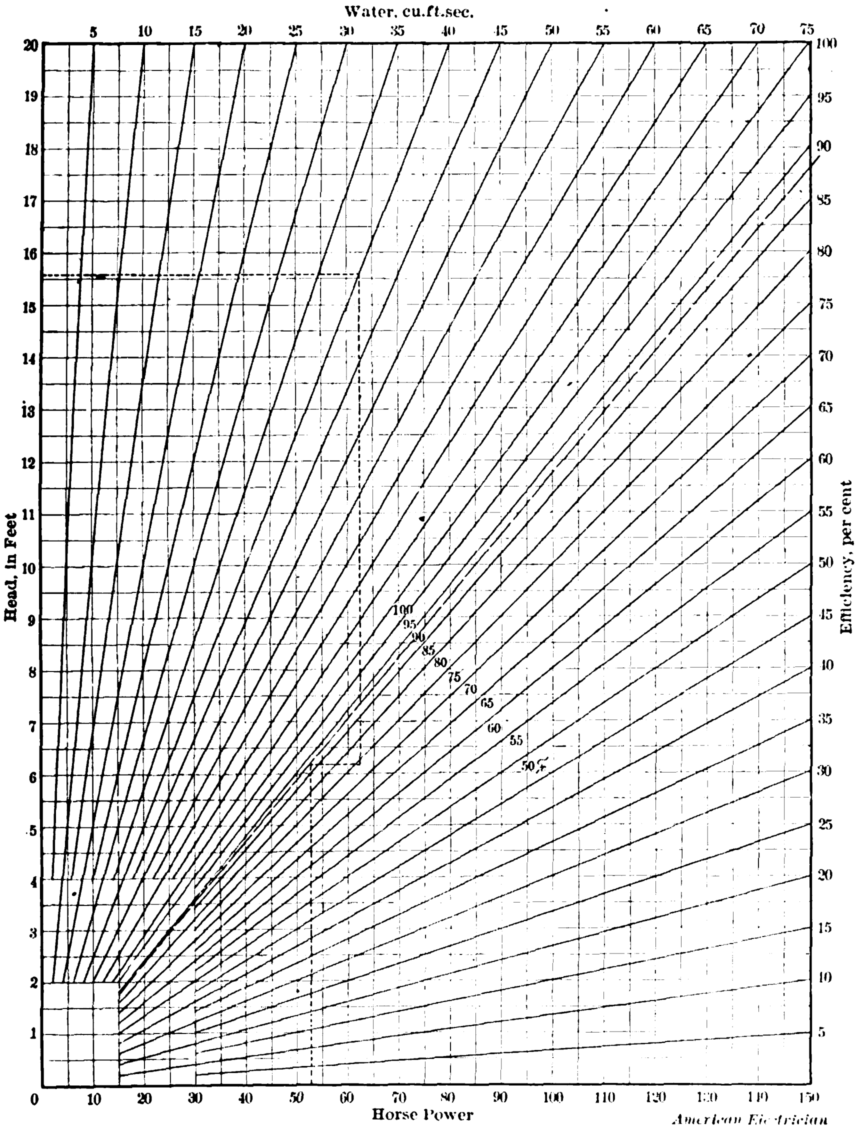

DIAGRAM FOR DETERMINATION OF HORSE POWER OF WHEELS AND TURBINES.

To use the diagram, start with the value of the head on the left margin, pass horizontally to the radiating line representing the given quantity, thence pass vertically down to the proper efficiency line, then pass horizontally to the inclined conversion line, thence vertically down to the HP line along the base of the diagram, where the proper value may be read off. With heads or quantities in excess of the maximum value of the diagram, the scale may be assumed changed to ten times that graduated, and the resulting HP read off to a scale either ten or one hundred times that graduated, according to whether one or both the argument scales have been amplified. One or two other arrangements of the lines indicating respectively the heads, quantity and efficiency have been used, but the one here given is offered where compactness is the prime requisite.

As an example, with a head of 15.6 ft., a quantity of 40 cu. ft. per second, and an efficiency of 75 per cent., the HP is 53.2.

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NOTES.

Electrolysis from Electric Railway Currents.—Electric railway superintendents will find much to interest them in a United States Senate document, dated October 29, 1897, and containing reports, accompanied by a number of maps, on electrolysis from electric railway currents in the District of Columbia.

Lightning.—Professor Trowbridge, of Harvard University, in recent experiments has found that the length of electrical discharges between widely separated points varies directly with the E. M. F. Discharges 4 ft. long were produced by means of an E. M. F. of 1,200,000 volts, and Professor Trowbridge has made the calculation that for the discharge of a flash of lightning 1 mile long, at least 1,000,000,000 volts would be required. The apparatus with which the experiments were performed consists of 10,000 Planté storage cells and a glass-plate condenser of sixty leaves.

Columbia University Lectures. In co-operation with The American Museum of Natural History, and under the auspices of Columbia University, a series of lectures will be given at the Museum, Central Park (77th Street and 8th Avenue), Saturday evenings, at 8 o'clock. The lectures for February will be on electrical engineering, as follows: Feb. 5, Mechanical Sources of Energy, by Prof. Frederick R. Hutton; Feb. 12, Generation of Electrical Energy, by Prof. Francis B. Crocker; Feb. 19, Transmission of Electrical Energy, by Dr. A. E. Kennelly; Feb. 26, Utilization of Electrical Energy, by Prof. William A. Anthony. The lectures will be illustrated by slides and experiments. Tickets of admission are required, which can be procured, without charge, by application to the Secretary of Columbia University.

Electrical Engineering at Union College.—A course of electrical engineering which was started in the fall of 1895 at Union College, Schenectady, N. Y., is at present complete in its several branches. An arrangement has been effected between the college authorities and the General Electric Company by which students in the junior and senior classes are admitted to the company's works at regular scheduled times under the direction of their instructor, with the privilege and opportunity of studying and inspecting the plant and operations, and of being regularly instructed therein by their instructor. This work is systematically arranged and given simultaneously with the corresponding class and laboratory work, to which it forms an important and valuable adjunct. Prof. Olin H. Landreth is in charge of the electrical engineering course.

The Milliampere.—In medicine the milliampere appears to occupy a place of unique importance, for Dr. W. D. Hedley, in the London *Electrical Review*, says that the history of electro-therapeutics since 1878 "is largely the history of the milliampere"! It appears that one medical authority lays claim to the invention of this unit of such surpassing medical importance, and the *New York Medical Journal* (January, 1889) ascribed its discovery to—of all men in the world—a late gynæcologist, Sir Spencer Wells. It appears, however, that Mr. W. H. Preece in 1877 suggested the adoption of the milliweber (ampere was substituted for weber by the Paris Electrical Congress of 1881) as a convenient unit for measuring weak currents, which suggestion bore immediate fruit.

Cost of Arc Lighting.—In a recent report, Mr. Horatio Foster gives the cost of arc lighting from a number of municipal plants, the figures being based upon data obtained from official reports issued by the respective municipalities. Mr. Foster finds that of New York State plants, the cost of arc lighting at Jamestown is 2.15 cents per lamp hour; at Batavia, 2.23 cents, and at Dunkirk, 2.51 cents. The lamps in the two last mentioned towns are of 1200 c. p. and of 2000 c. p. at Jamestown. The following data is given for the cost of lighting per lamp-hour from Massachusetts municipal plants: Peabody, 2.2 cents; Marblehead, 2.39 cents; Danvers, 3.29 cents; Middleboro, 4 cents; Braintree, 4.55 cents; Reading, 5.53 cents; Wakely, 7.52 cents —all of the lamps being of 1200 c. p. Mr. Foster considers that for average depreciation, 7½ per cent is a safe figure. He states that a fair cost for an arc light plant is from $200 to $250 per lamp installed.

A University Department of Instruction by Correspondence.—West Virginia University, of Morgantown, W. Va., is now ready to begin the work of giving instruction at a distance from the University, by correspondence, to be carried on by a series of printed instruction and question sheets. The course in electrical engineering is in charge of Profs. Hodges, Aldrich and Jones, and comprises the branches of electricity and magnetism, electrodynamic machinery, electrical wiring and distribution, electric street railway systems and working, electric coal mining, electric lighting systems, telephone systems, electric power transmission, electric light plants and central station working. Hereafter, the University will be in continuous session, and correspondence students may spend the summer quarter in resident study at Morgantown.

Economy of Electric Power.—The Metropolitan Street Railway Company, of Kansas City, Mo., which operates some 120 miles of surface, cable, electric and horse railway, and 16 miles of electric elevated road, has during the past several years been making extensive improvements of its properties, particularly in the way of introducing electric power. Recently the electrical equipment has been extended by the addition of another Walker generator of 2400 amperes and 550 volts, there now being four stations equipped electrically out of a total of eleven. A careful account has been kept of the cost of generating power in one of the electric power stations; including the items of labor, repairs, oil and waste, fuel, water and miscellaneous, and covering a period of four months, the average cost per KW-hour was found to be .48 cent. The cable machinery in one power house is operated by a motor at a large saving, the cost being $366.23 per month as against $1,025.25 when operating with a steam plant.

Electric Switching.—The use of electricity for switching purposes has been adopted by the Hoboken Shore Road, which provides connecting facilities between the railroad companies entering Hoboken, and the numerous warehouses and docks which line the west side of the North River from Hoboken to the Weehawken. The new plan was put in regular operation Jan. 4, a 540-HP General Electric locomotive being used, which resembles in appearance the electric locomotives now handling the entire freight traffic of the B. & O. R. R., through the Belt Line tunnel at Baltimore. The overhead trolley is used, the wire being No. 00 in size, current being obtained from the Hudson Electric Light Company. The dimensions of the Hoboken locomotive are: Length over all, 29 ft.; width, 8 ft.; height over trolley stand, 13 ft.; wheel base, 5 ft., 6 ins.; truck centers, 12 ft., 9 ins.; weight, 57,000 lbs. A motor is mounted on each of the axles of two four-wheel trucks.

A Small Accident with Large Consequences.—The daily papers reported several weeks ago a serious break down in the power house of the Chicago Metropolitan Railway, it being stated that two armatures were burnt out, shafts broken, a fly-wheel burst, etc., in consequence of excessive current due to too many trains starting up at once. We find that, as usual, the reporter depended upon his imagination instead of going to the trouble of ascertaining the real facts of the case. It appears that one of the engines of the power house had been dismantled in order to make some repairs, which threw a heavy load on the other generating machinery. The governor belt of a small engine operating the condenser slipped, and in racing its fly-wheel—about 4 ft. in diameter—burst, but without doing any damage of consequence. Owing to the main engine having then to run non-condensing, the traffic of the road had to be lightened until the condenser engine was repaired.

The Corliss Steam Engine.—In an article in the London *Electrical Review* on the progress of the steam engine during the past twenty-five years, Mr. J. S. Raworth says that many inventors had tried to improve on the steam engine of Watt, but it was left to George H. Corliss to do it. During the past twenty-five years the record of progress in mill engines is simply, he says, a history of the Corliss engine. He adds that if ever Lancashire should desire to spend some infinitesimal fraction of 1 per cent. of its wealth in honoring those who have contributed to its success, it ought to raise a statue to the memory of G. H. Corliss. "It should be made of white marble, and standing in front of the Town Hall, Manchester, bear this inscription: 'When your boilers are equal to my engines, you will save the cost of this statue in gold'" Has any statue been erected to the memory of Corliss in the land of his birth?

Municipal Electrical Inspection.—At the recent annual meeting of the Underwriters National Electric Association, a resolution was adopted, addressed to the Executive Committee of the National Board of Fire Underwriters, asking the Board to consider the advisability of encouraging the establishment of municipal electrical departments in the various cities and towns throughout the country, for the regulation and control of electrical fire hazard. At the same meeting the action of certain municipal electrical departments in drawing up sets of electrical inspection rules at variance with the National Electric Code was condemned. In other words, the association in one breath welcomed the establishment of municipal electrical departments, and in another condemned some of said departments for instituting special sets of rules—and without special requirements there would be no cause for the existence of such departments, since the underwriters' inspection service assures sufficient protection to the public from fire hazard. It is directly against the interest of electrical contractors to have such departments instituted, on account of the arbitrary interference which will undoubtedly result, and there seems to be no public reason for their existence.

Candle Power of Search Lights.—As usually expressed, the candle power of a search light is obtained by equating the total flux of light from the area of the crater exposed to the reflector, with the total flux from the opening of the search light. That is, by multiplying the area of the search light opening by the candle power of the ray, and equating it to the product of the area of exposed crater and a hypothetical candle power, which latter is the unknown quantity in the equation and, when found, is the commercial rating of the search light. For instance, suppose the beam has a diameter of 20 ins. and a candle power of 2000, and that the diameter of a circle equivalent to the area of the crater is .5 in. The total flux from the search-light opening is $\frac{\pi}{4} \times 400 \times 2000$; and from the crater $\frac{\pi}{4} \times .25 \times x$, where x is the hypothetical candle power expressing the rating of the search light. This reduces to $2000\ (400 \div .25) = x$, or in this case the rating of the search light would be 3,200,000 CP. Thus, in order to find the candle power of a search light, 1°, the area of exposed crater is estimated, and the diameter found of the circle which corresponds to this area; 2°, the candle power of the ray, is measured by the ordinary photometer, usually at a distance of several thousand feet from the search light, the mean of measurements at the axis and near the periphery being taken. The diameter of the ray being known, its ratio to the equivalant crater diameter is squared and multiplied by the photometer candle power. This method of expressing the candle power of a search light is unsatisfactory, giving as it does absurd figures for the candle powers. The factor of practical importance is the amount of illumination furnished by the ray, which is the product of its cross-sectional area by its photometer mean candle power, the latter (leaving aside absorption and assuming perfect parallelism of component rays) being the same at all distances from the search light. Rational systems of light units have been proposed that would numerically express a rating in accordance with the latter statement. Such a system would also obviate many of the other absurdities inherent in the present system of dealing only with intensity of light and not with the more direct factor of illumination. The man who defined a 2000-CP arc light as one which, when placed at the intersection of two streets, would send 500 CP up and down each street, was scarcely less logical than, in some respects, the system which misled him.

Rapid Telegraphy.—Dr. Crehore and Lieut. G. O. Squier in a paper read before the Franklin Institute, Jan. 19, described some tests of their synchronograph on the telegraph lines of the British Government, in which a Wheatstone receiver was operated by the alternating current in transmitting telegraphic signals. The longest loop tried was 1097 miles—from London to Glasgow, Aberdeen, Edinburgh, and return to London by a different pole line; the loop contained some iron wire and also 48 miles of underground cable. It was discovered that the synchronograph could operate the Wheatstone receiver approximately three times as fast as the Wheatstone transmitter on any line. The authors conclude that the results of their experiment show that the use of an alternating E. M. F. which does not rise suddenly and fall off so abrubtly as is the case with that of most transmitters, but which rises gradually from zero to a maximum and falls again to zero as gradually, is the best kind of transmitting current for use on actual lines with distributed capacities.

Photographing by Light.—The sensational newspaper press recently devoted columns to an announcement that Tesla had taken photographs by means of light from vacuum tubes, in proof of which a reproduction of a vacuum-light photograph of his hand was printed. Had the announcement been that he had been *unable* to take photographs by light from vacuum tubes, there would have been some occasion for sensational comment. That the vacuum-tube light is one of the oldest known electrical phenomena, does not appear to be generally recognized. Discovered by Hawksbee in 1709, it figures prominently in the electrical literature of the last century. For almost a half-century vacuum tubes have, under the name of Geissler tubes, formed part of the equipment of college laboratories. In fact, at any time since Daguerre's discovery, photography by means of the vacuum-light has been possible. It is even quite probable that photographs have frequently been taken by means of this source of artificial light, and with no inkling that a wonder was being wrought.

Electrical Exhibition.—The applications for space in Madison Square for the Electrical Exhibition to be held there next May, are flowing in so rapidly that we learn every available foot will very soon be exhausted. The position of consulting engineer of the exhibition has been accepted, on the invitation of the management, by Prof. F. B. Crocker, who, as is well known, is President of the American Institute of Electrical Engineers, Professor of Electrical Engineering at Columbia University, and senior member of the Crocker-Wheeler Electric Company. A committee has been organized to take charge of exhibition matters other than commercial, among whose members are Prof. Morris Loeb, of the University of New York; Prof. W. E. Geyer, of Stevens Institute of Technology; Prof. Chas. A. Doremus, of the College of the City of New York; Mr. Herbert L. Webb, of New York Telephone Company; Lieut. G. O. Squier, U. S. A., and Dr. Park Benjamin. The New York Electrical Society, which is the oldest body of its kind in the United States, has lent the aid of its name and prestige to the exhibition, in view of the very worthy object for which it has been organized. An advisory committee has been appointed by the Society, composed of its present officers and past presidents, and consisting of Prof. M. I. Pupin, Prof. F. B. Crocker, Prof. Willard Case, Dr. C. E. Emery, and Messrs. Dunn, Sinclair, Osterberg, Geyer, Riker, Coho, Kerr, Small, Pendleton, Wetzler, Mailloux, Francis W. Jones and J. W. Lieb, Jr.

Important Electric Railway Decision.—The Circuit Court of the United States for the Southern District of New York has sustained the validity of a patent granted August 25, 1885, to Frank J. Sprague, on the suspension of electric railway motors. The patent in question is on the method of suspending the field magnet by journaling it on the axis of the driving wheels at one end, suspending it from a spring on the truck or the car body at the other, and carrying the armature shaft upon its pole pieces parallel to the shaft of the driving wheels, the two shafts being connected by gearing. One of the claims of the patent is for a spring support at both ends of the motor. The decision states that "If Sprague's patent was for merely handling and centering one end of a motor of a carriage upon the axles of the driving wheels, and suspending the other by a spring from the body of the vehicle or the truck, it would be shown from that case [one involved in a previous decision] to be wholly lacking in novelty, and void. He was not a pioneer here, and could have a valid patent for only what was new in his method of making the power of the electrical current turn the driving wheels. No one had before, however, hung a field magnet at one end upon the axle of the driving wheels, and at the other upon a spring from the body of the car, or the truck, and an armature axle upon the pole pieces of the magnet, parallel with, and geared to, the axle of the driving wheels for driving a car by a current of electricity." This latter combination, the opinion states, simplified greatly the required structures, improved their results, and came into immediate use, and the court therefore believes that the invention of the combination seems to well support these claims of the patent. An order of the court was subsequently issued suspending action under the decision for a month, in order to permit the defendants to appeal the case, should they so desire.

New Method of Preventing Sparking.—Mr. J. Fischer-Hinnen writes a short but interesting article in the *Elektrotechnische Zeitschrift* of Dec. 30th, describing an ingenious method of preventing sparking at the brushes of direct current generators, which seems to be a modification of the now well-known Swinburne device with its auxiliary poles. As described, it is applicable only to the consequent pole type of machine, such as the "Manchester," old "United States," etc., and is in principle briefly as follows: The neutralization of the reaction being but indirectly related to the prevention of sparking, he omits it altogether from the consideration of the question and confines his attention solely to the production of induced poles in the line drawn through the neutral or non-sparking position, the poles having the same polarity as that of those which the armature is advancing in the course of its movement. Like Swinburne, he uses auxiliary pole pieces in the neutral zone, cast integral with or bolted to the field magnet core, but, unlike him, places no windings on these poles. In the consequent pole type of generator he describes, these are, of course, placed midway of the legs on which the spools are wound. In the first place, the number of ampere-turns per auxiliary pole is determined as in the case of the Swinburne winding, and extra turns to make up this number are then added to the field spool above the auxiliary pole piece and omitted below, the reverse being the case for the opposite leg. The total energizing force thus remains the same as in the case of the ordinary machine, but the poles are produced as in the Swinburne generator. The author describes a recent test on a generator of a nominal output of 400 amperes built in this way, where a load of 1200 amperes was taken without brush movement, and he claims that it was impossible to tell by the closest scrutiny of the brushes whether the whole 300 per cent of load was off or on. Particular advantage is claimed for this construction in the case of variable speed motors, as the speed may be varied through the "widest limits" by simple field commutation without sparking, thus giving a control without loss of energy.

Early Days of the Electric Railway.—In his presidential address before the recent Northwestern Electrical Association, Mr. H. C. Higgins gave the following amusing account of the electric railway craze of some years ago: "We all went into the electric street railway business with the greatest hopes of financial success. It was a very attractive business. The man who was running a horse car or a mule car line would go to a town where they were running the new electric street railway, he would see the beautiful cars, with every seat occupied by a passenger, gliding over the track without any apparent effort and at a more rapid rate than he had ever hoped to accomplish on his line, a uniformed conductor on one end, a uniformed motorman on the other, with everything bright and shiny. It was a beautiful sight to him, and frequently he did not go home until he first visited the office of Mr. John I. Beggs or Mr. B. E. Sunny, whose bright smiling countenances were only a continuation of the bright things he had just seen, and got prices from each of these gentlemen for electrically equipping his road at once. He went home, immediately consulted his board of directors, explained what he had seen and some of the things he had felt, and that night sent a night message accepting the proposition of one of the two contestants before mentioned. The next day he had a meeting of the council called, his franchise was changed from horse to electric, and he could not get his stuff quick enough in his mad desire to be the manager of an electric street railway, such as he had just seen. We all thought in those days that about all that was necessary was to secure a favorable franchise, and the electrical companies would do the rest, but I know of no writing that so fittingly applies to the result as a verse in one of Moore's poems which reads:

I saw from the beach when the morning was shining
A bark o'er the waters ride gracefully on,
And I saw from that beach when the eve was declining,
The bark was still there but the waters were gone.

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The nickels which we had expected to have supported our enterprise had, like the waters, gone and left our bark, the street railway, stranded."

Oliver Blackburn Shallenberger.—The death of O. B. Shallenberger, which occurred at Colorado Springs, Col., Jan. 24, removed one of the most brilliant of the band of electrical pioneers whose achievements have given the distinctive name of the "Electrical Age" to the latter part of the nineteenth century. Dying in the early prime of manhood—he was but thirty-seven years of age—and while engaged on one of the most comprehensive schemes of high voltage power transmission yet put under execution, his loss to the electrical profession and industry is a severe blow. Mr. Shallenberger was one of the first to enter the electrical field thoroughly equipped to scientifically cope with the problems which it presented, having been graduated in 1881 with high standing from the engineering course of the United States Naval Academy. It is interesting to note that Sprague, Duncan, Hasson, Cahoon, Greene, S. Z. Mitchell, Wilkes, Eyre, Emmett and several others known in the electrical field were all at the Naval Academy during parts of the same period. After several years' service at sea abroad a man-of-war, Mr. Shallenberger resigned his commission in 1884 to accept a position with the Union Switch & Signal Company, and the next year was selected by Geo. Westinghouse, Jr., who had just purchased the Gaulard and Gibbs American patents, to develop the alternating current system. How in a very short time he constructed from the crudest of elements the alternating current system of to-day, forms one of the most creditable chapters in electrical history, and one too familiar to require further notice here. Later he transferred his activities entirely to the field of invention, and in rapid succession produced a whole series of alternating current station measuring instruments, the shunt coil for series alternating current operation, and the meter known by his name—the latter one of the finest electrical inventions of the age. About 1891 the health of Mr. Shallenberger began to fail, and the condition of his lungs made it necessary for him thereafter to spend his winters in Colorado, where, in 1896, he found it advisable to take up a permanent residence. Notwithstanding the state of his health, he continued his professional work, and at the time of his death was engaged, as president of the Colorado Electric Power Company, on a scheme, now well under way, for the distribution of electric power throughout the Cripple Creek mining district. Of an extreme intellectual modesty and somewhat retiring in disposition, he was not, as those who enjoyed the pleasure of his friendship so well know, lacking in any of the attributes of human kindness and sympathy. In fact, it may be said of him that, though of determined character and strong will, he had no enemies, and that none who met him but rendered a tribute of admiration to his sterling qualities of mind and character.

Consulting Engineers.—In the course of a paper read before the New York Electrical Society at the January meeting, Mr. S. Dana Greene said that in the electrical field the consulting engineer, as in other engineering fields, is a necessary and proper connecting link between the manufacturer and purchaser. Broadly speaking, the function of the engineer is to see that his client who buys apparatus and installs it, selects, first, the system best suited to his particular local conditions; and, second, that purchasing he secures the best (though not necessarily the most) for his money. It is, however, equally his duty to learn what the manufacturer can reasonably be called upon to make, to consult with him freely and to obtain the benefit of his experience; also, to give him credit for work well done, and insist that bad work shall be promptly corrected. He referred to the fact that many consulting engineers, especially those who have only recently commenced practice, seem to think that it is improper for them to consult with the manufacturer, to examine his plant or to ask him for information or advice, through fear, apparently, that in so doing they may be accused of partiality or undue bias, or that such a proceeding would be derogatory to their dignity as independent engineers. The inevitable result is that specifications often contain provisions which are a source of annoyance and expense to the manufacturer and purchaser alike, and Mr. Greene adds that for the former to ask the engineer or purchaser to make modifications is a proceeding always difficult and delicate to undertake, and often results in trouble for all concerned. Mr. Greene said he feels satisfied that no reputable establishment would refuse admittance to engineers who desire to obtain necessary information concerning their apparatus with a view to the intelligent preparation of specifications. As an instance of the general neglect to keep in mind standard apparatus when drawing up specifications, he referred to the record of the estimates supplied for such apparatus by one firm in a single year, amounting to 300 for direct current, and 300 for alternating current apparatus, besides which there were between two and three times as many preliminary estimates required to answer inquiries of customers, all the above being in addition to the regular work of the engineers of this company on standard lines of apparatus, of which there are over thirty. Mr. Greene believes that if the requirements of electrical machinery under the headings of efficiency, heating, regulation, sparking and insulation were formulated under some general rules, and if the methods of tests to determine results were uniform, the work of consulting engineers and manufacturers would be vastly lessened. Such, unfortunately, is not the case at present, and specifications on these points vary widely, both as to requirements and as to methods of tests. It is consequently believed that this forms a matter calling for action from some scientific non-partisan organization. The American Institute of Electrical Engineers is pronounced just such a body, and could render a great service to the entire electrical business by taking up the matter for consideration and action.

Small and Large Transformers.—Some recent data on the saving secured by the substitution of large transformers of high efficiency for old types of small capacity, illustrate the importance to central station managers of looking closely into the transformer question. In one case, 57 small transformers built in previous years were supplanted by 18 of one of the latest types. The total light capacity of the superseded apparatus was 1499 lights, and of the newly installed transformers, 1624. The total core loss of the old transformers was 5866 watts, of the new only 1348. The saving in dollars and cents is estimated at $527.70, or equivalent to a saving per light-capacity per year of 36.2 cents. Neglecting all the advantages of the change except those accruing from the decreased core loss, the expense of the change will be met in one year and nine months, while the light capacity of the plant is increased 9 per cent. In another instance, 40 new type transformers supplanted 53 old ones. The total light capacity of those replaced was 1135 lights, of the new, 1070. The core loss in the old type transformers was 4845 watts, of the new type 1343 watts. In this case the annual saving is about $409, and corresponds to a saving per light per year of 35.2 cents. The expense of the change, counting core loss alone, will be covered in two years and nine months. 3502 additional watts are available for sale, increasing the income by $525 per year, while by the use of lamps of a higher economy, some 535 KW-hours additional are also available for sale. In another case the regulation of the station had been very poor and the lamp bills had increased to such an extent that the question demanded immediate attention. While the saving was comparatively small, the beneficial results brought by the change have proved highly satisfactory. In still another case, 81 small transformers of old type were replaced by 3 of a new type. The core loss of the old transformers amounted to 2568 watts, of the new ones 280 watts. The resultant saving per annum is $267, the saving per light capacity per year being 25.74 cents. This is an all day station, and it is calculated that only eight and a half months will be required to wipe out the investment. In another plant, 193 old type transformers were superseded by 37 new ones, the total light capacity of the former being 6035 lights, and of the latter 8210 lights. The total annual saving is $683, and the total saving per light capacity 14.68 cents. In five years and two months the cost of the change will be fully covered. The capacity of the plant has been increased 36 per cent., the energy required to operate it decreased 47.1 per cent., and 116 additional light capacity obtained without adding to the station apparatus. If these lights were burned but three hours daily, the result would be an additional annual income of $960. On account of the improved regulation entailed by the change, high efficiency lamps are now used, which adds $109.46 to the total annual saving. In a Western central station by centralizing the transformer distribution, the rate of switchboard income was changed from 4 cents to 12 cents per KW-hour. Another Western plant had its 1140-volt circuit equipped with old style transformers, which showed 6 to 7 amperes in the day time, while with the new transformers only a fraction of an ampere is shown.

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New Serial Articles.

With this issue is begun the publication of two serial articles—on armature windings and on interior wiring—which, we believe, will be much appreciated by our readers. The first-mentioned will take up all the usual types of windings in turn, and while the main object is to give a thorough understanding of the principles concerned, the information will be in sufficient detail for practical guidance in winding. The articles on interior wiring will be comprehensive in their scope, including detailed plans for wiring all classes of buildings, from a small cottage to the largest office building. According to the policy of this journal, each installment will be, as far as practicable, complete in itself. The attention of new subscribers is called to the series of articles on "American Telephone Practice," which forms unquestionably the most valuable contribution yet made to the practical side of telephony.

Fuses and Circuit Breakers.

In this issue is published the conclusion of the discussion on "Circuit Breakers vs. Fuses," though our columns remain open to those who took part for any rejoinders they may consider necessary, and to others who may have something new to say on the subject. The discussion has, we believe, been of value in bringing out fully the particular merits of the devices under consideration, and in making the electrical public acquainted with a new type of fusible cut-out which, we believe, will finally entirely displace the unsatisfactory open-air fuse. As to the relative merits of fuses and circuit breakers, the conclusion to be drawn would appear to be, that each type of cut-out has its own field, and that neither will displace the other. The discussion, in fact, bears some resemblence to that which took place upon the introduction into the commercial field of the alternating-current system, when partizans on one side maintained that the direct-current system was doomed, while those on the other could scarcely find terms sufficiently strong with which to characterize the imperfections of the new comer.

An Important Electric Railway Decision.

The recent decision of Judge Wheeler sustaining the Sprague patent on the method now employed for the suspension or electric railway motors, will, if sustained on appeal, be of far-reaching effect. The opinion of Judge Wheeler is very brief, and its reading does not at all make clear the grounds upon which he based his decision. It is stated that if the Sprague patent was for merely hanging and centering one end of a motor upon the axle of the driving wheels, and suspending the other by a spring from the body of the vehicle, or the truck, it would be wholly lacking in novelty, and void. The opinion then proceeds to say that no one had before hung a field magnet at one end upon the axle of the driving wheels, and at the other end upon a spring from the body of the car, or truck, "and an armature axle upon the pole pieces of the magnet, parallel with, and geared to, the axle of the driving wheels for driving a car by a current of electricity." The context would seem to imply that the vital point is therefore the use of electricity as a motive power in combination with a spring suspension for the motor, or possibly that together with the use of an armature axle having a bearing in the pole pieces of the magnet and geared to the axle of the driving wheel. On account of this vagueness, the present decision cannot be considered to foreshadow the conclusion that will be arrived at on appeal.

The Power Factor.

That the power factor should be considered a somewhat mysterious quantity is perhaps not surprising in view of the fact that it is often defined as "the cosine of the angle of lag." When an alternating current passes through a choke coil, for example, having, say, a power factor of .9, the mind of one not instructed in alternating current mathematics can be brought to conceive without much difficulty, that an opposing inductive E. M. F. inside the coil may cut down the energy to .9 of that due to a direct current of the same value and voltage. If, however, he tried to connect the idea of an angle of 65 degs. (the cosine of which is .9), with the current flowing and the E. M. F. existing at the binding posts, in all probability he would most promptly give it up and consider alternating current phenomena too difficult for his comprehension.

In fact, the use of an angle and the cosine in connection with the power factor is entirely an artificial conception. If, in a particular case, the impressed E. M. F. is 100 volts and the power factor is .9, then the free E. M. F. is 90 volts, and the actual energy is $90 \times 100 = 9000$ watts. That is, the inductive E. M. F. set up in the coil requires 10 volts of the impressed E. M. F. to balance it, leaving but 90 volts free to do work. It should be added that the actual value of the inductive E. M. F. in this case would be 42 volts, but the direct reaction between it and the impressed E. M. F. is but 10 volts, for reasons that may be made apparent by laying down the sine curves of the two E. M. F's. However, the point to be borne in mind is that the power factor is a fraction expressing the part of the alternating E. M. F. measured at the terminals of an inductive circuit, which is free to do work. If the voltage is 50 and the current 10, with no inductance in circuit the watts consumed in the circuit would be $50 \times 10 = 500$; with a power factor of .6, the watts would be $30 \times 10 = 300$, for the reason that 20 volts of impressed E. M. F. are "held up" through the presence of inductance, in the same manner that the useful E. M. F. of a battery of 25 storage cells would be reduced from 50 volts to 30 volts, if 5 of the cells were connected in opposition.

Inefficiency of the Steam Engine.

One of the most persistently held errors is that the steam engine is a shamefully inefficient machine, and one of the speakers at the recent Northwestern Electrical Convention went so far as to say that "the best type of modern stationary steam engine only yields power equivalent to, say, about 13 per cent. of the energy of good steam coal, *leaving 87 per cent. for improvement.*" The first part of the statement is approximately correct, but this inefficiency is not the fault of the steam engine, but a result of the operation of the inexorable second law of thermodynamics, according to which only a fraction of the heat supplied—the ratio of the range of working temperature to the maximum absolute temperature—is available for transformation into another form of energy. This law applies not only to the steam engine, but to all machines and processes for the transformation of heat, including gas and air engines, thermo-piles, thermo-electric batteries, thermo-magnetic engines, etc. It follows from this, that the part of the above statement italicised is absolutely incorrect.

Let us determine the real efficiency as a machine, of a steam engine generating a horse power on 1.7 lbs. of coal per hour, the steam having an initial pressure of 100 lbs., and exhausting into a condenser maintaining a vacuum of 26 ins.; further, assume that the coal has a thermal value of 14,000 units, and the boiler an efficiency of 70 per cent. The number of heat units in 1.7 lbs. of coal is therefore 23,800, and since the heat equivalent of a horse power hour (as found by dividing the foot-pounds by the mechanical equivalent of heat) is 2,545, the efficiency on this basis is but 10.7 per cent.

The absolute temperature of steam at a pressure of 100 lbs. is 797 degs., and that of vapor at a tension corresponding to 26 ins. of vacuum, 587 degs. Therefore, the amount of heat available for transformation into work is $(797 - 587) \div 797 = 26.2$ per cent. which is another efficiency of the steam engine—its thermal efficiency or the percentage of heat delivered which it could transform into mechanical work were it a perfect machine.

As the boiler only utilizes 70 per cent. of the heat in the coal burned in its furnace, but $.7 \times 23{,}800 = 18{,}660$ units of the heat in the coal is delivered to the steam engine, and of this only 26.2 per cent, or 4889 units are available for transformation into mechanical work. But a horse power is equivalent to 2545 heat units, and consequently the engine under consideration has an efficiency as a heat transformer of 52 per cent. This latter, and not 10.7 per cent. or 26.2 per cent., is the true efficiency of a steam engine working under the conditions given, and the figure approaches 70 per cent. for the most economical types of modern engines. While between 100 per cent. and 50 per cent. or even 70 per cent., there is a considerable margin, it should be borne in mind that heat is a form of energy that, unlike electricity, cannot be directed into one desired channel alone, so that wastes by by-paths are everywhere occurring. For this reason it is unfair to compare the efficiency of any heat engine, with, say, an electric, weight or spring machine, as electricity, gravity and resilience are forces that can be exactly directed.

The Hunter Alternating Current Patents.

In another column we print a communication from Mr. R. M. Hunter, in which he takes exceptions to some editorial comments which appeared in our January issue, concerning several patents recently issued to him and purporting to "cover broadly the alternating current system." The comments in question referred to the absurdity of a patent issuing at the present time purporting to broadly cover a system that has been in commercial operation for years; of which every fundamental principle had been known a half a century or more, and their application to electric light and power distribution covered by patents antedating the date of application of the Hunter patents, with the exception of one relating to the operation of transformers in parallel—this issuing, however, twelve years previous to the date of the recent Hunter patents.

To particularize, the transformer principle was embodied in the apparatus used by Faraday in his memorable discovery and demonstration of electro-magnetic induction, and afterwards applied by Ruhmkorff and Varley in the induction coil. The method of stepping up and stepping down alternating current voltages was so well known a half a century ago as to form the subject of a text-book description. The transformer as applied to telephony, was described by Berliner in 1877, and a patent on a similar arrangement granted to Rossetti in 1880, and a year later the Deprez patent for electrical distribution by the aid of step-up and step-down transformers was issued. In 1882, or a year before the date of the application for Mr. Hunter's earliest patent, the celebrated demonstration of the Gaulard & Gibbs alternating current system was given at Westminster Aquarium, London, and the Zipernowski-Deri patents on the structure and arrangement of transformers for use in parallel were issued a few years later—the novelty of these latter patents, however, being questionable in view of the practice already established of direct current parallel distribution.

In the face of these facts, there is every reason to view with suspicion patents issued in 1897 claiming to "cover the entire art" of alternating current operation and "all of the apparatus employing transformers for reducing potential now in use or likely to be used"—a suspicion which becomes more accentuated when it is seen that the first mentioned patent is merely based on a division of an application for a telephonic arrangement, which arrangement, judging from an accompanying patent office drawing, is in itself a mere rehash of the earlier work of Berliner, Rossetti and others. But Mr. Hunter maintains that the justice of his claim to the prior invention of the alternating current system is upheld by the Patent Office, and he mysteriously remarks that "there is a great deal relating to the alternating current system which the public knows nothing about, but will in due time possibly be more enlightened."

In reply it may be said that, in view of the adverse fate met by so many patents when brought up in court for adjudication on their merits, a Patent Office search or grant predicates little or nothing as to the real value of a patent, which is issued on a prima facie showing and not upon a judicial determination of all the facts; and that if much is yet unknown concerning the alternating current system, the Hunter patents certainly disclose nothing but what was well known even before the date of the earliest Hunter application. As to the Hunter railway patents, the reason given why litigation has not been carried on under their broad claims is scarcely valid in view of the history of the case of the Thomson-Houston Company against the East Reading Railway Company, which case was founded on the Hunter patents, but subsequently abandoned and new suits instituted under the Van Depoele patents for substantially the same invention.

A SENSITIVE MIRROR GALVANOMETER.

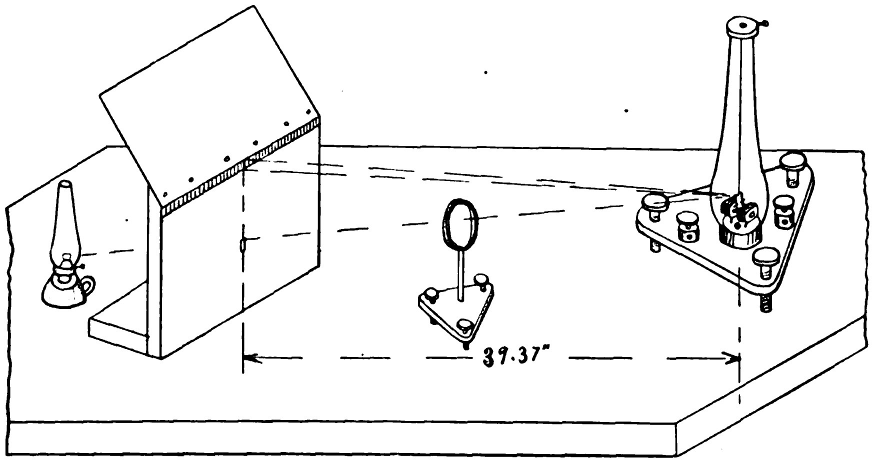
BY JAMES F. HOBART.

The several galvanometers recently described in the AMERICAN ELECTRICIAN possess many points of merit for particular and different kinds of work, but their construction is a matter of considerable difficulty, and requires accurate and high-grade work on the part of the constructor.

The instrument described herewith is intended to obviate, almost entirely, the necessity for skilled manipulation, upon the principle which pays so well in the machine shop, viz., that the whole be so designed in its several parts, that the machine work shall be reduced to a minimum, or even dispensed with altogether, save a little drilling, etc.

The above scheme has been adopted in making the galvanometer, which, after having been turned out "with jack-knife and pliers" will give results closely approaching those received from a more elaborate and costly instrument. Fig. 1 gives a view of the instrument complete. It consists of four parts—the lamp, the screen, the lens, and the coils and needles.

For the lamp, a bicycle lamp leaves nothing to be desired, though a common kerosene hand lamp, as shown in the engraving, answers every purpose. The vertical board is as high as the lamp, and the scale is attached to the top edge of the board. The scale may be an ordinary yardstick, or ruler fastened to the board, or it may be a strip of paper ruled to milimeters, and shellaced to the board.



[FIG. 1.—SENSITIVE "HOME-MADE" GALVANOMETER.

The tin shade is simply to cut off some of the light which otherwise would be reflected over the top of the scale, and dim the bar of light. A clean, sharp slit may be made by cutting a somewhat large hole in the board, and covering it with a bit of cardboard or brass, in which a slit of the size, found by experience to be best, has been cut.

The lens may be an ordinary reading glass, or it may be one of the cheap lenses to be obtained in almost any shop, for a few cents. Almost any form of lens can be made to answer, but preferably, it should be a double convex, of very long focus—16 ins. to 18 ins. If a reading glass is used, it may be mounted by placing the handle through a hole in the base-board as shown. If a plain lens is to be used, a cheap mount is shown by Fig. 2. A bit of board is cut out as shown, and the hole through it is just a trifle smaller than the lens. A narrow V-shaped groove is then cut around the center of the inside of the hole, and a saw kerf run into the board as shown. This allows the lens to be pressed into the groove, and the spring of the wood holds it there.

The six leveling screws are common brass wood-screws, 4 ins. long, about ¼ in. in diameter, with the top of the head filed off flat. The edges of the disk thus formed may be milled in pretty good shape by rolling the edge of the head under a single-cut file of the required degree of fineness. Place the screw on a hardwood board, or better yet, on a sheet of lead, and by rolling under a file, the milling can be quickly done. By all means, use a lathe if you have one, in preference to the file method.

The third member of the family is built on a bit of board cut about 8 ins. on a side of triangular shape, as shown. Three leveling screws are let in, and two binding posts are placed in connection with the coil. These posts are shown in the engraving. A common medium-sized lamp chimney is procured and fitted to a circular piece of wood ¾ in. thick. The wood is screwed to the base, and the coils are fastened to the wood; the mirror must be placed one meter (39.37 ins.) from the scale.

Another circular piece of wood is fitted to the top of the chimney, as shown in Fig. 1. A detail plan and section of this piece is shown by Fig. 3. It is bored out to fit on the chimney, and a ½-in. hole is bored in the center, completely through the wood. A wire with a sort of thumb-head is bored into the wooden cap so as to pass through the center of the ½ in. hole. A bit of cardboard is glued into the bottom of the large hole, and a pin-hole, punched through the exact center, permits the suspension fibre of the needle system to be carried to the wire and wound up by turning the thumb-head above described. The coils may be made according to the work to be done. I have three sets of coils with my instrument. The first is made of about 50 ft. of single-silk, copper magnet wire, of such size that it has a resistance of about 8 ohms to the 1000 ft.—about No. 18, or No. 19, B. & S. gauge.

A form for winding the coils is shown by Fig. 4. It is made of wood, held together with two screws. A couple of binding wire are laid in before the coil is wound. About six layers of the wire above mentioned can be made out of one-half the 25 ft. mentioned. Two of these coils are used, connected in series and to the binding posts. After winding, the binding wires are fastened, the coil is drenched with shellac and placed in the cook-stove oven for an hour. The core is then removed, additional binding placed on the coil if found necessary, and again baked at low heat for two or three hours. This holds the coils permanently. Two coils are to be used, and the needle system suspended between the coils, which are placed ⅜ in. apart.

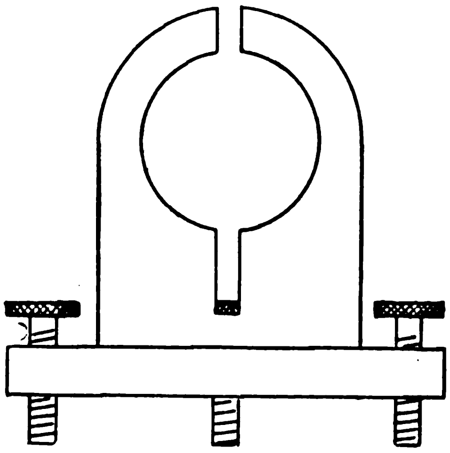


FIG. 2.—METHOD OF MOUNTING PLAIN LENS.

I have three coils with my instrument, two in each set, and use either set, as the work demands. I have also three sets of needles, which will be described later. The second set of two coils is wound of No. 33 or No. 34 wire, and has a resistance of about 10 ohms, or 20 ohms for the complete set of two. The third coil is wound with No. 36 wire. Nearly ¼ lb. was put on the two coils, and the combined resistance of the complete coil is about 1000 ohms—500 ohms each.

For the needles with the low-resistance coils I use a common sewing needle. The temper was drawn, the eye and point filed off, leaving a bit of wire 1¼ ins. long. A nick was filed in the center, then the needle was hardened and magnetized, and broken through the nick, thus giving two needles magnetized pretty near alike. A piece of cardboard 2 ins. × ½ in. was pierced, and the needles stuck through it, as in Fig. 5, and held by a drop of hot sealing wax.

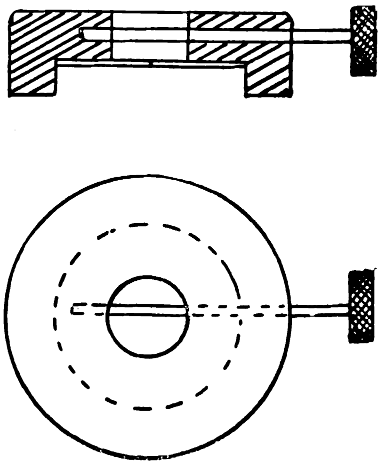


FIG. 3.—CAP FOR TOP OF GLASS CHIMNEY.

A bit of mirror, *m*, was waxed to the top of the cardboard, and the suspension fibre fastened between the mirror and the cardboard, as shown. The upper end of the fibre is carried to the cap on top of the chimney, attached to the thumb-head wire, and wound up until the lower needle hangs in the middle of the coil, and the upper needle clears the top of the coil about ¼ in. The instrument is now ready for setting up and adjusting in the usual manner.

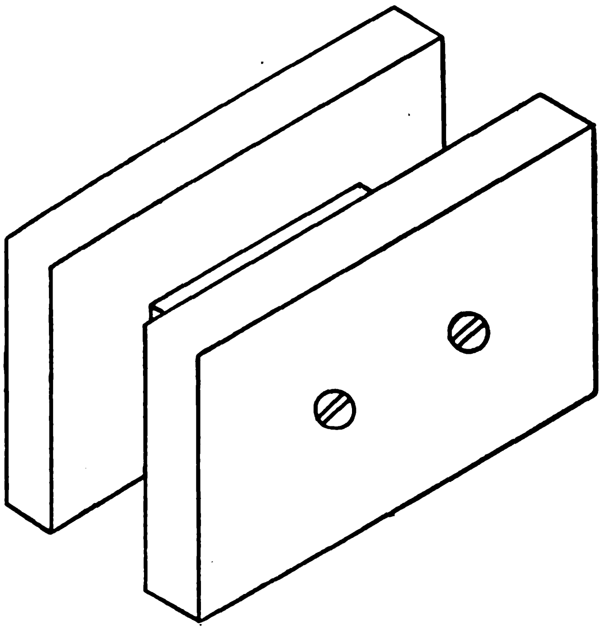


FIG. 4.—FORM FOR WINDING COILS.

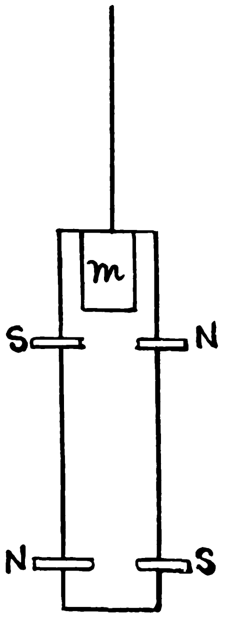


FIG. 5.—NEEDLE SUSPENSION.

The second set of needles is made in the same manner, except that I used pieces of fine watch spring, less than ⅛ in. wide, and placed three pieces together with a single thickness of paper between, for each needle. The pieces were file-marked, hardened, magnetized and broken in pieces, the same as the needles.

Finding that the light needles and the low-resistance coils gave an instrument readily affected by thermal currents, I made the third set of needles of steel tape about ⅜ in. wide, and used five pieces in each needle, separating each with paper. All the needles in the three systems were ⅝ in. long. The third set made a very heavy set, but in connection with the 1000-ohm coils, proved very sensitive, although slow moving.

Different effects were secured by using either set of the needles with the other coils, making six possible combinations. Where extreme sensitiveness is not required, I found it desirable to use a directing magnet, and not depend upon the torsion of the suspension, or over-strength of one of the needles, to return the beam of light to zero.

With 1000 ohms in each arm of the bridge, and 6 volts in the battery, a considerable deflection is obtained by changing *R* a single ohm, and with the bridge arranged 1000 to 1, at *a* and *b*, the galvanometer readily deflects down beyond the capacity of the bridge, which was .001 ohm, with 1000 ohms galvanometer resistance.

For the suspension in this instrument, I used a hair. It was quite fine, micrometered about .002 in. in diameter, and was probably from the head of a dark-haired lady. From the needles to the point of suspension, there were about 8 ins. of effective hair. Just how much better the instrument would be with a raw-silk fibre, I have no means of knowing at present, but it was as delicate as will be required for any ordinary work.

As to the "figure of merit," I have not had opportunity to determine that point, but will do so, and report later. The "efficiency" of the low-resistance instrument is rather greater than that of the high-resistance form, while the "figure of merit" is greater, the more turns of wire are placed on. For measuring very low resistances, the low-resistance coils will give perhaps the best results.

* * *

INTERIOR WIRING.

INTRODUCTORY.

BY CHARLES E. KNOX.

In the series of articles of which this is the first installment, we shall start at the point where the electrical engineer or expert commences—with the floor plans—indicating and outlining the method of procedure in "laying out" the outlets and circuit wiring, and following it up with the electrical contractor through the various stages of installation, to and perhaps beyond, the point where the current is turned on.

It is not the purpose of this introductory article, to give the history of interior wiring. This has been done by others far better qualified and in such a manner as to leave little to be desired. It will rather be our intention to present and discuss the methods and practice of interior wiring in vogue at the present day.

We will begin then, where we would start in actual practice, and outline the procedure followed in locating the various outlets, selecting, by way of example, a typical building, and also discussing the questions of chases for the risers, and locations of the distributing centers.

Before selecting a concrete example, however, let us consider the various ends we may accomplish in properly distributing the lights. All kinds of ordinary lighting may be divided, empirically and for convenience, into three groups or classes, as follows: 1st. General Illumination; 2d. Local Lighting; 3d. Decorative Lighting.

Under the first head are included all kinds of lighting the object of which is to so arrange the lights as to provide a diffused illumination through a given space, as, for example, a parlor, dining room or ball room.

In contradistinction to the first class, the second has for its end, the illumination of some particular object. The lighting of draughting rooms (when drop lights used) and business offices, are types when is essential to arrange the lights with reference to tables and desks.

The name of the third group indicates the function it has to perform, and includes dome and tower lighting, illuminated signs, etc. In this case the lights are generally arranged so as to accentuate some architectural feature of a building, following some of the more prominent architectural lines.

Having thus briefly outlined the various kinds of lighting, which we will meet later, let us begin at once with the subject particularly set aside for present consideration.

Suppose, we have before us a set of building plans, and that in conjunction with the architect or owner we are called upon to mark on the plans the location of the electric light outlets.

As we are in a position to choose, let us select a simple case, and assume that the building to which our attention is called is a private dwelling.

Commencing at the bottom of the house, the cellar first attracts our notice.

The lighting of this floor is distinctively of the first class or group, and as the various portions of the cellar are generally allotted to their several purposes at the time the lights are located, its disposition is a simple matter. It is well to bear in mind, however, that the stairs leading from the cellar should be properly lighted by an outlet either at the foot or head. If it be placed at the foot, it should be controlled by a switch located at the head of the stairs. Many a damage suit for injuries sustained by accidents, occuring on stairways and in passages, has hinged proof, whether the stairs or passages were properly and sufficiently lighted.

In the laundry, very little light is required as the work here is generally done during the day. The lights here also should be located with reference to the objects which they serve to illuminate. In this connection it might be proper to remark that the lighting of the service and servants' portion of the house should be limited to that amount only which is necessary and proper for the work to be carried on. It is unwise to provide extra outlets in these places, for the reason that, as a rule, servants use their own discretion in lighting, and should you give them more than the amount necessary, they will not fail to use it.

If the range in the kitchen has a hood, it is well to provide for outlets under the hood, as it is otherwise difficult to provide adequate lighting. Outlets should be placed over the sinks, tables, etc. Lights should also be placed in all closets deep enough to require them; in placing such outlets preference is given to the ceiling, thus avoiding interference with the shelves. The lights in the butler's pantry should be so placed as to light the closets properly from the outside, as the closets are generally too small to admit having the lights placed inside.

The problem of lighting the dining room is a very simple one. Notwithstanding the fact that architects and others of artistic tastes, always object to ceiling lighting, that is invariably the way it is done, because it is the only way to illuminate the room sufficiently. Of course, the ceiling lights may be supplemented by others, but we must depend on the ceiling for the general illumination. The lights may be grouped in one or more chandeliers, or, if the ceiling is paneled and the design admits it, single lights may be placed between or in the center of the panels. Sometimes a floor outlet is desirable for the purpose of providing a source of current for decorative lighting on the table itself.

Passing on to the library, we find that we are again forced to place dependence chiefly on the ceiling, for the reason that the wall space is generally occupied by the bookcases. If there is any opportunity for locating a couple of side brackets, they are desirable. Here also a floor outlet may be needed for table or desk lights.

In the parlor and reception room it is wise to provide for both ceiling and side lighting. The side lights should be so located as to avoid cutting up the wall space to such an extent that they will interfere with hanging space for pictures. Plug outlets are frequently placed in the base-board for flexible connections to piano lamps, torchère lights, etc.

The lighting of the main hall and the stair halls is generally accomplished by a ceiling outlet in the main hall, and by a side outlet placed in the center of the hall wall, in each of the upper floors.

Taking up next the lighting of the bedrooms, let us state at the outset, that the only proper method of locating the lights in rooms of this character (where the lighting depends almost entirely on the location of the furniture) is to make paper templates of the same scale as the floor plan, of the different articles of furniture and lay them out on the plan. When this has been done and a satisfactory arrangement has been made, the outlet may be located.

A light should be placed on each side of the bureau, the outlets being from 4 ft. 6 ins. to 4 ft. 10 ins. between centers. Sometimes a single outlet is placed over the center of the bureau for a two-light drop fixture. This is not as satisfactory in most cases as a single light on each side. Except in fairly large rooms, ceiling lights can be readily dispensed with, because the bed generally interferes with their usefulness. It is wise to provide plug outlets for connections for a table light next to the bed and for other table lights should they be so desired.

In the bath room, one bracket light near the wash basin, is generally sufficient. Avoid placing this outlet over the center of the basin, as this would interfere materially in the placing of a mirror.

In the servants' bedroom, a single bracket light near the window usually answers all purposes.

Having satisfactorily arranged the location of the outlets, let us consider for a few moments the question of the number of lights we should provide at the various outlets.

In the first class of lighting (general illumination), the total number of lights to be placed in any given space, depends primarily on two variables: First. The total cubical contents of the space to be lighted. Second. On the color and character of the decoration of walls and ceilings.

In the calculations for determining the amount of light in a given space, a 16-CP lamp (having a clear-glass globe) is adopted as a unit.

It is a difficult matter to formulate any rule for ascertaining the exact number of these lamps required, but with the lamps exposed to view (*i. e.*, the lamps being so arranged as to afford direct light and not reflected light) the number of cubic feet per lamp will vary between the limits of 300 and 1000 cu. ft. The former figure will serve for cases, such as ball rooms, banquet rooms, etc., where unusually brilliant lighting is required. The latter figure may be used for cases where only a fair amount of light is needed, the ceilings and walls being white. For the average case, where the space must be well but not extravagantly lighted, the color of the decoration being fairly light, it is safe to allow from 500 to 700 cu. ft. per lamp. Where the decoration is dark, the number of lamps should be increased, as the light-absorbing quality of the color scheme increases. As was stated above, these are not hard and fast rules, and must be used with discretion.

Quite frequently the architect will object to the conventional side-bracket or chandelier and will say, "Can't you get up some scheme so you can place the lights where they won't be seen, and yet have the room evenly and brilliantly lighted?" To do this successfully is quite a difficult task. Theoretically speaking, the ideal illumination would be attained by the distribution of a very great number of small light-giving bodies distributed over the space to be lighted, keeping the light density constant and producing a diffused illumination of the entire space. The effect produced in this way would be delightful to the eye, as it would avoid the production of "spots" of light and also prevent the distracting effect of the present methods of lighting.

If, however, the architect objects to the usual methods of lighting, his services must be enlisted in order to break away from them; for if *special* lighting is to be provided, special provision should be made for it in the architecture of the room, for its successful accomplishment.

An attempt to produce the effect referred to above, is frequently made by dividing the light into a great number of units, using receptacles, or wall-sockets, hidden behind cornices or placed above or behind a translucent material, such as ground or opalescent glass. In the last case, the ideal is more nearly attained, but the number of cases where this method can be carried to a successful conclusion are extremely rare. Another method still is to expose the lights, but weaving them in with the artchitecture so that they are less noticeable.

If the architect is sufficiently interested in the result sought for, to go so far as to modify his designs where the circumstances and conditions admit it, the effect produced generally contributes no less to the beauty of the architecture, than to the success of the lighting. It is never wise, however, to adopt any of these methods unless the conditions readily lend themselves to this type of lighting. There are enough "horrible examples" around the country, where lighting by the use of single lamps, arranged in geometrical or other forms, has been attempted, where the conditions neither demanded this method nor warranted its use.

Having satisfactorily located the various outlets, there still remain two other subjects for discussion and consideration with the architect, and these are the locations of the chases for the vertical portions of the feeders and the points suitable for placing the centers of distribution.

We will take these up here only so far as they interest the architect in making provision for them.

In both cases the best method of procedure is to ascertain what places are available for the purpose, leaving the selection of the particular ones to be used until the circuit work is partially laid out.

In regard to rising points for the feeders in mains, the following precautions should be used in seclecting chases:

First. The space should be amply large to accommodate all the feeders and mains likely to rise at that given point. This seems trite and unnecessary, but it is the most usual trouble with chases for the risers. Formerly architects and builders paid little attention to the requirements for chases for electrical work, but in these latter days of 2-in. and 2½-in. conduit, they realize that these pipes are not as invisible and mysterious as the force they serve to contain, particularly when they have twenty or more such conduits to stow away in a building where no special provision has been made for them.

Second. If possible, the space should be devoted solely to electric wiring. Steam pipes are objectionable on account of their temperature, and these and all other pipes are objectionable in the same space as the electrical conduits, for if the space proves too small, the electric conduits are the first to be crowded out. The phrase, "The electrical contractor can 'string his wires' anywhere," is heard too frequently to need comment.

The chase should be continuous from the cellar to the roof, or as far as needed. This is necessary in order to avoid unnecessary bends or elbows, which are objectionable for many reasons.

In similar manner, the location of cut-out cabinets or distributing centers should fulfill the following requirements.

First. They should be accessible at all times. Never place a cut-out cabinet where you would have to disturb a man when he is taking a bath, to replace a fuse. He will be mad even if the fuse serves to protect a circuit in his own room, but he will be madder still if it is for some other room. Put the cabinets therefore, where you can quickly and easily get at them at all times.

Second. They should be placed sufficiently close together to prevent the circuits from being too long.

Third. Do not place them in too prominent a position. This is objectionable from the architect's point of view.

Fourth. They should be placed as near as possible to the rising chases, in order to shorten the feeders and mains supplying them.

MERCHANT MARINE WIRING.

BY E. W. COUNTISS.

Wiring for electric lights on ship-board is very different from wiring on shore, not so much in principle, as in details. The average first-class wireman on shore is not so good on board ship. The rules that govern the case of one ship will not apply to all, but certain precautions must always be taken to avoid fire risks from short circuits, leaks and grounds, whether the plant be large or small, and it is the object of this article to point these out.

Much judgment must be used as to when is the best time to begin wiring a ship. If you wait too long, extra work will have to be done, which could have been avoided by starting sooner. If started too soon, the probability is that some of the wire-ways will be in the way of some necessary joiner work, and have to be removed. By having one or two men on hand, holes can be bored, tubes and moulding put in place while the panel work is being set up, thus sometimes saving a week's extra work. This applies to a new ship in course of construction, but on an old ship it is a case of "make the best of it."

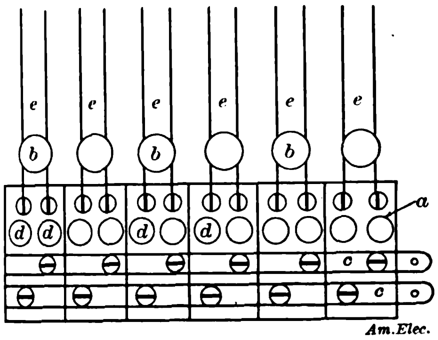
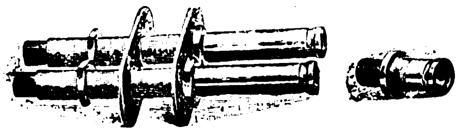


FIG. 1.—DISTRIBUTING CENTER.

As the cabins and state rooms are finished in the best style, it is here that the greatest difficulty is encountered. The location of the lights is marked out by some representative of the ship's owners, and the question arises how to get the wires to them, without disfiguring the surroundings. The feeders will give the greatest trouble, as a clear run for a moulding to take a No. 00 or No. 000 wire, is not always just in the right place. To find a place for it sometimes even a smaller moulding gives trouble.



FIGS. 2 AND 3.—DECK AND BULKHEAD TUBES.

The mouldings must be placed so that they will be almost undistinguishable from the ship's finish. A board of inspection on one of the new cruisers was standing in the ward room, and seeing the fixtures asked the question, "Where are the wires run?" The moulding carrying the mains for this particular case were $2\frac{1}{4}$ ins. wide, placed on the outside of the panel work, and yet they were hardly discernible.

The distributing centers, if judiciously placed, will save both time and expense. As the contract specifies that there shall not be more than 2 or 3 volts drop at the lamp situated the greatest distance from the switchboard, these centers must be well located; and as there are allowed only six or eight lights on a circuit, the fewer these centers are in number, the more compact will be the system. If properly located, it is possible to take in a nest of state-rooms and also some of the cabin lights on two decks, and so cover considerable space. No. 14 B. W. G. wire is a good size to use, starting from the fuse blocks, as it is easily spliced and easy to fasten to the socket and fixture terminals, as well.

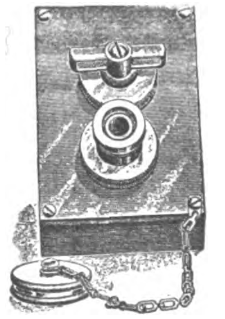


FIG. 4—WATER-TIGHT SWITCH AND RECEPTACLE.

The feeders preferably should be stranded, as they are then more easily handled and adapt themselves to the various turns in the mouldings, besides being more flexible and lessening the danger of fracturing the conductor. These feeders should have a double pole fuse and switch at the switch-board, and every distributing center its own feeder. Fig. 1 gives an idea of the arrangement of the feeder and circuit switches of a distributing center. *a*, are double-pole cut-outs; *b*, double-pole switches; *c*, connecting bars; *d*, double-pole fuses, and *e*, circuits to lamps.

Wherever possible, keep the mouldings inside of the state rooms, as they are less seen there than anywhere else; but where it is necessary to cross the saloon to a light, run the moulding on the bottom of the deck-beam. If it is flat and level you will have no trouble, but if it is cased in with a fancy moulding, make a deal with the master-joiner and have him plow enough out of it to make a wire casing. This permits all the beams to look alike. Screw this moulding on, so that it can be removed at any time; for if is nailed on, it is more trouble to take off, besides the danger of damaging it beyond further use.

Where a moulding is run on a bulkhead or across a panel, do not make it look like a patch. It may be that the wires pass through a bulkhead, 6 or 8 ins. from the deck or bulkhead; run the moulding from deck to deck, which gives it the appearance of a pilaster; or if run horizontally, let it extend from one bulkhead to the other.

Wherever the wires pass through wooden bulkheads or beams, they should be protected by hard rubber tubing, the sharp edges being removed on the inside at the ends. Wherever the wires pass from deck to deck, water-tight tubes should be used. No matter how staunch the ship, there is bound to be some give to the different parts, and as the wires become a fixed part of the ship, every precaution must be taken to secure the wires from injury. The best insulation will wear through with continual chafing, so extra precautions must be taken where vibration takes place. Only the very best rubber-covered wire, further reinforced with a strong and durable braid, should be used. Water has caused as much trouble as almost anything else, whether the source be rain or salt water from heavy seas; and extra precautions must be taken to keep this from the conductors. Wherever a joint is made, it should be well soldered, the flux thoroughly removed, and then reinsulated with a first-class tape, over which a good coat of insulating paint or varnish is applied.

Figs. 2 and 3 illustrate a pair of deck tubes and a bulkhead tube respectively. The method of applying the deck tubes through wooden decks needs no comment; but if the deck plank is laid over and on top of a sheet of iron or steel, as in the naval ships, it is well to take still further precautions to secure water-tightness, as the deck may leak at a seam 10 ft. from the tube, and water work down around the tubes, flowing on top of the sheet of metal and below the planking.

The plan adopted by the writer is to drill a hole the size of the tube at the root of the thread, then tap the hole so that the tube will fit tightly. Before putting in for good, red-lead both hole and tube, and you are safe from leakage. The lower washer plate can then be set up with the lower nuts, but first put red lead on the washer plates both top and bottom.

Wherever it becomes necessary to carry the wires outside, always use a water-tight tube. The bulkhead tube is used for passing through water-tight metal bulkheads, and is secured in place the same way as the deck tube. These tubes are lined with hard rubber their entire length. At one end, the hole is enlarged so that a moulded soft rubber gasket may make the inside tight where the wire passes through. The gaskets can be secured of any inside diameter to fit the wire used, and are forced home by means of a gland nut on the end.

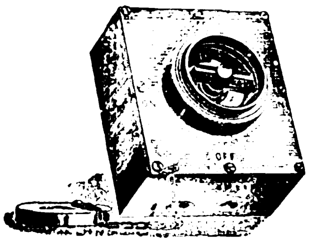


FIG. 5—WATER-TIGHT SWITCH.

When using these tubes, coat the wire and the inside and outside of the rubber gasket with an insulating compound or paint, and you are safe, when set up. Some of my readers may think that some of these details may be superfluous, but seven years' experience has almost convinced me that it is impossible to do too much.

If you will notice the joiner work, you will see that there is not a right angle or a straight line anywhere. Everything is curved and beveled. When you run your moulding make it parallel with the surface or finish to which it is the nearest. This will make the intervening space parallel and add to the good looks of the job.

In the shaft alleys and between decks, it is better to run lead-covered wire. The fumes of acids, oils, etc., attack the braid of ordinary wires, and in a short time it is gone. Branches can be taken off of the mains by using branch water-tight junction boxes, or by means of soldered joints. The latter method is the cheaper, and just as good, if properly done, which is as follows:

Remove the lead for about 1½ ins., then ⅜ in. or ½ in. of insulation. Make a solder joint of your branch (using lead-covered wire for it), and have the lead set back about the same distance as in the mains, and solder. Wrap this securely with tape so that there are no weak spots. Take a piece of sheet lead of the same thickness as the lead on the wire, about 2¼ ins. square. Form this around the joint closely and with a blow-torch (small jet) or soldering iron solder the joints where the wire is surrounded. Trim off the surplus metal on each side of the branch, and solder the edges. If neatly and properly done, the joint will not be over 3/16 ins. larger than the main line. Water-tight fixtures ought to be used in all places exposed to moisture.

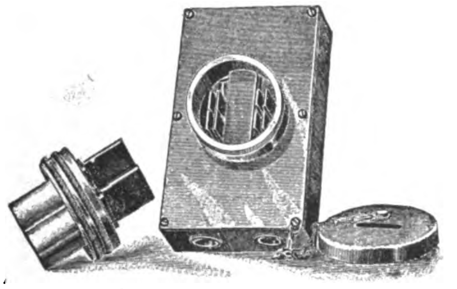


FIG. 6.—WATER-TIGHT SWITCH.

Where wires cross each other in the mouldings, a method employed was to bore a hole in the back of the moulding, sink a hole in the foundation woodwork, and lace the branch under the opposite wire, and thus leave ¼ in. of wood between the two wires.

Where lights are not needed constantly, or not always in one place, portable lights, such as cargo reflectors, are provided. Water-tight receptacles are installed, into which a plug can be inserted when the light is required, and the opening closed when not needed. Fifty feet is a good length to allow for the cord, which should be what is now known as double-conductor hemp portable.

Fig. 4' shows a water-tight combination switch and receptacle, used for the attachment of a portable lamp.

Fig. 5 shows a water-tight 40-ampere gang switch. These will be dwelt on more fully in a later article.

Fig. 6 is a search light receptacle, which is seldom, however, used in merchant work.

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Ozone.

In a recent paper Prof. Blondin states that theoretically 2.24 lbs. of ozone can be produced by 1 HP-hour of electrical energy. By the older methods only about 2 per cent. of this amount could be generated per HP-hour, but recently an efficiency as high as 15 per cent. has been attained. The principal loss is in the heat developed in the process, which consists in sending a current of air through passages between whose sides electric discharges are maintained—usually sparks from one pole over a glass partition to the other. The voltages used vary from 6,000 to 10,000. Ozone is employed industrially principally in the oxidation of hydrocarbons. The most important commercial application at present is in the production of vaniline from iso-eugenol.

ELECTRICAL APPARATUS FOR AMUSEMENT.—II.

MAGICAL CANDLESTICKS.

BY NEVIL MONROE HOPKINS.

The magical candles and candlesticks represented in the following illustrations, were designed for the purpose of furnishing light, and a source of flame, for the modern conjurer's table. They are capable of mysteriously extinguishing and relighting themselves as many consecutive times as may be required, at the wave of the magician's wand, and, if brought forward near the edge of a small stage, create a very surprising effect when exhibited on a light board placed across a pair of trestles, small round tables, or other equally innocent looking rests or supports.

The appearance of these magical candlesticks mounted on a light trestle, is shown in Fig 1, viewing them from the audience. The effect of this trick is perhaps enhanced by standing the candlesticks on pieces of newspaper, and covering them with tall glass shades, giving the appearance in a very marked manner of absolute isolation from things surrounding. In addition to this the shades may be covered with silk handkerchiefs or colored scarfs, allowing the candle flame to be seen through the colored silk, as it apparently jumps from one candle to the other, through the glass shades, silk scarfs, and intervening atmosphere. The candles can be made to answer queries, and count out the spots on cards, in addition to numerous other tricks which may occur to the performer.

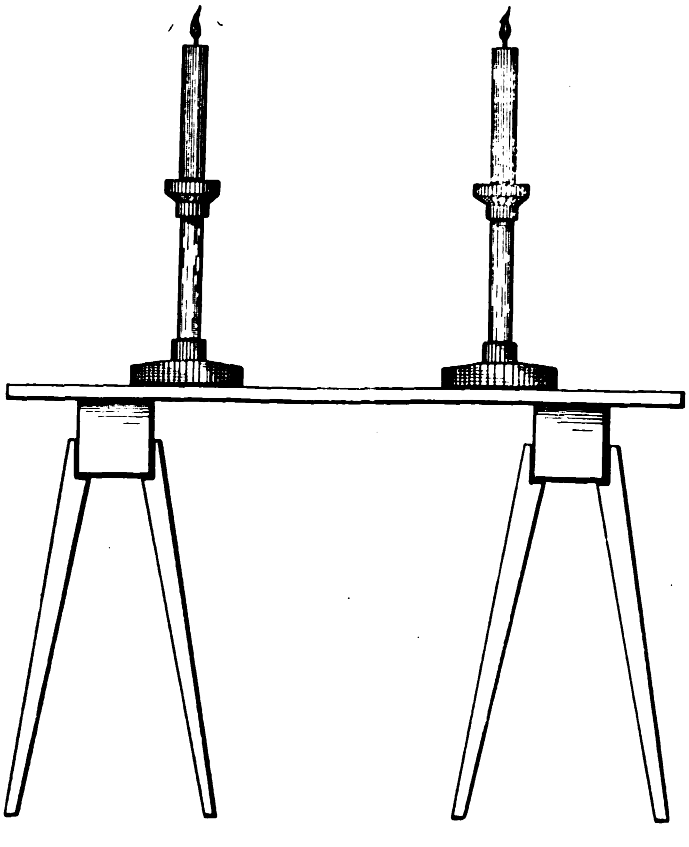

FIG. 1.—MAGICAL CANDLESTICKS.

The supports or stems, of the candlesticks, are made of glass for effect, as they serve to discourage electrical theories as regards the lighting of the candles, and add to the effect of total isolation. These glass stems are very conveniently cut from glass tubing, known to chemists as combustion tubing. This tubing is rather thick, but may be cut, as the average reader doubtless knows, by running a notch around with a sharp triangular file, using turpentine, to promote its biting. The tube is then very easily separated at the file cut, if made sufficiently deep, by pulling on the two pieces in addition to the breaking or bending strain.

A cross-section through one of these candlesticks is represented in Fig. 2. The base, *A*, and the top, *B*, are turned up on the lathe from thoroughly seasoned hard wood, and cemented on the glass combustion tubing. Walnut is an excellent wood for this purpose, if thoroughly seasoned and dry, As the high-tension discharge from an induction coil, or plate machine, is employed to light the tiny gas jet at the candle tip, it will be readily seen how important the matter of insulation is, requiring only the best and driest materials.

The base contains three leaden weights, (two of which are shown in section at *C* and *D* cast in the auger holes, *HH*, to serve as weights and contact plates), the two shown in the sectional view being connected to the ends of the stout wires, *GG*, by casting. Two small gimlet holes, as shown, join the auger holes with the little opening under the glass stem, through which the wires pass.

Two very fine, bare copper wires, No. 36 or No. 40, are soldered to the ends of the heavy wires, *G G*, and carried up through the glass tubing and soldered to the ends of two stout wires, *F F*, which pass through the wooden cap as illustrated, terminating with soldered joints, with the little copper plates, *E E*. The joints of this fine wire soldering should be sponged off with water, if zinc chloride has been used as a soldering fluid, as it would not take it long to corrode the fine wire away if left unwashed. It is next to impossible to detect the presence of these fine wires in the glass stem, even upon close examination, although they are amply large to carry the high-tension current employed.

The copper plates, *E E*, are attached to the inside portion of the wooden cap by soldering on a little sharpened spur in the center, and pressing the spur into the wood. If the inside of this cap is well shallaced, it will tend to hold the plate in place, in addition to adding increased insulation. A little metallic tube, *M*, fits tightly in a small gimlet hole in the wooden cap and is cemented around the joint.

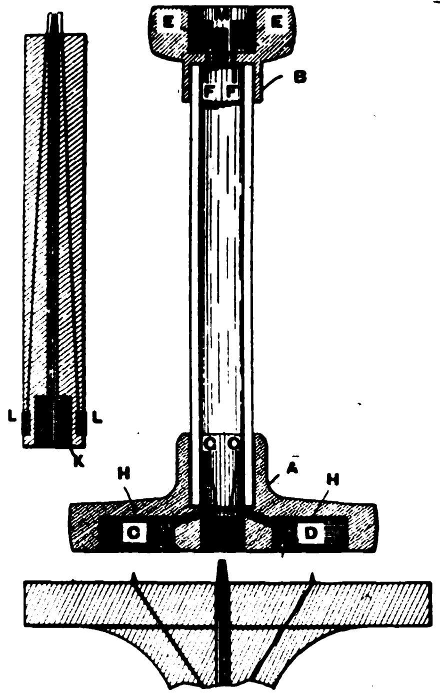

FIG. 2 AND 3.—DETAILS OF CANDLESTICK.

It can now be readily seen how electrical communication is established between the wires and the sharpened points in the little table top, partly shown in section, and the little contact plates in the cap of the candlestick.

By referring to Fig. 3, a section through the electrical candle can be seen. This can be made from a real wax candle, but is much more durable if made from wood and enameled. This also must be of the driest material for the sake of insulation. A tiny brass tube runs through the center, as illustrated, ending in a fine point, or tip, at the top, and terminating in a little auger hole or recess at the bottom, with a soft-gum stopper, *K*, having a tiny hole through its center, pushed in as shown. Two little contact plates, *L L*, are let into each side of the candle after soldering on two fine insulated wires and boring fine holes through the candle, as illustrated.

It is desirable to shellac the covering on these wires before pulling them through, giving them the best possible insulation. The little tip at the end of the brass tube should be blackened to resemble a candlewick, and the fine wires which run to the top must have platinum tips where the wire bends over the tube, in order to stand the heat when the gas is ignited. It will also be evident that the soldered joint must not be very near the flame, as it would be better economy to invest in a couple of inches of platinum wire and have the joint away from the flame, than to have tips that are too near the little gas jet, melting the solder and putting the magical candles out of service. The little plates, *L L*, must be about the size of the ones in the cap of the candlestick, in order to make proper contact, and the size of the candle at the base must fit the candlestick.

Let us now examine the system for the gas supply from the little table, to the tip of the platinum wires. The small brass tube with the tapering point, as fitted to the little round table in Fig. 2, projects about ½ in. above its top, as shown, entering the soft-gum stopper in the recess of the base of the candlestick, when the magician places it carefully on the table. The gas ascends through the glass stem to the cap, and passes through the little brass tube, *M*, with its own tapering point, which in turn enters the soft-gum stopper in the base of the candle.

It is now clear how the electrical connections are established between the sharp points in the table top and the platinum tipped wires at the top of the candle. It will be readily seen that the candlesticks may be lifted up from the table at any time during their exhibition, and the candle taken out in order to impress on the audience that they are only "ordinary candlesticks and candles." It is also very evident that the placing of a newspaper under the candlestick would in no way interfere with the lighting of the candle, as the tapering tube and sharpened points would immediately puncture the paper and make the necessary connections. It should also be observed that the glass shades and colored scarfs have no effect on the working of the trick, as the tiny flame requires but little oxygen, and will burn for a long time under a large shade. Of course, for the sake of the shade it must be large and not come too near the little flame.

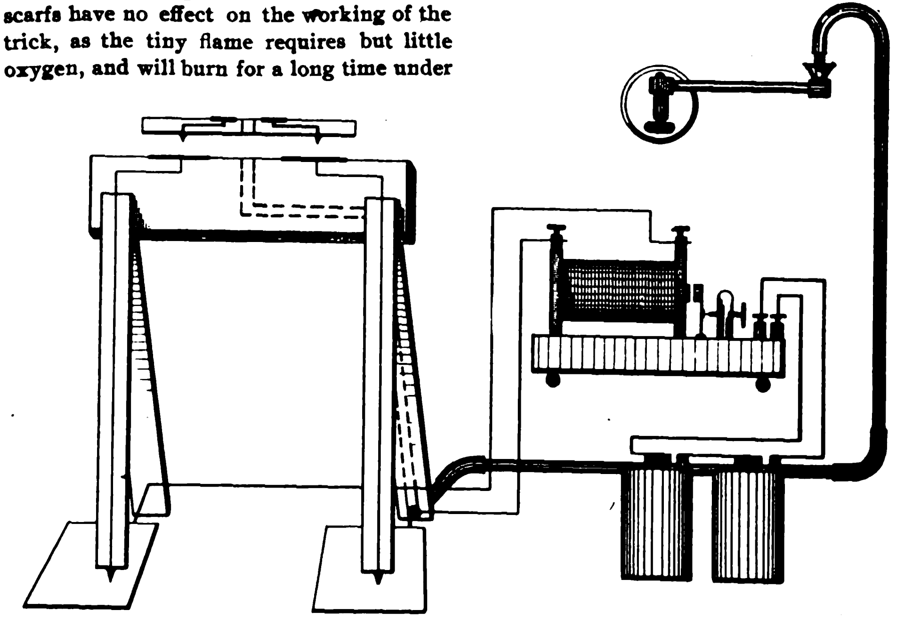

FIG. 4.—CONNECTIONS OF APPARATUS.

These candles with very minute blackened tubes, filed down to the size of mere wicks, with a gentle gas supply, resemble so closely real candles that a distance of only a few feet from the front of a small stage, renders detection very difficult. It is also readily seen that the bottoms of the bases of the candlesticks can be covered by gluing on dark green baize, covering the weights entirely, allowing only a tiny slit for the gas tube to pass through, which allows of the candlesticks being examined very closely if real candles are skillfully put in the place of the electrical ones.

Fig. 4 illustrates the connections for a "doctored" pair of trusses and light board. While small round-topped tables are much easier to equip with the necessary wires and gas tubes, the light board and trusses present, perhaps, a more innocent appearance. This arrangement is shown only as an example, however, for varied means of exhibiting the candles are sure to suggest themselves to any one making the candlesticks and equipping them with the electrical requirements.

The floor-contact plates in this illustration are shown uncovered, but, of course, are worked under a thin carpeting, the sharpened points on the bottom of the truss legs pricking through and making the necessary contact. It is seen that the board in this illustration is also equipped with sharp points which are designed to make contact with little copper plates on the truss. The gas is supplied by a small tube let into a groove in one of the legs and covered with putty and painted over. The leading-in wires from the induction coil must be of the best rubber-insulated type, and the floor-contact plates should have a thin coat of shellac on both sides, relying on the points to cut through the shellac on top in order to make metallic contact. The rubber stopper joint must be duplicated in the board where it rests on the truss and must be fitted with a little tapering tube as described in connection with the candlesticks. An induction coil capable of giving a 2-in. spark is necessary, or else a large plate machine.

In working the trick, the gas is first turned on and regulated from the key at the burner to give the proper sized flame at the "wick." The induction coil or plate machine, is kept running all the time, but at sufficient distance from the audience to prevent the sound from the buzzing of the coil or the running of the plate machine being heard. Having regulated the key at the burner to give the proper pressure, the candles are extinguished by compressing the rubber tube which may be employed to make the gas connections, or in any other convenient manner. With two candles, it is, of course, necessary to have two entirely independent gas supplies and electrical circuits.

To light the candles it is only necessary to allow the gas to flow (provided the coil is in constant operation) by releasing the pressure on the tube. By alternately compressing and releasing the rubber connecting tube, the candle is extinguished and relighted. By equipping two candles with independent gas supplies, and furnishing a thoroughly insulated switch for the induction coil, in order that the same coil may alternately supply the two candles with the electric spark, the candle flame may be made to "jump from one candle to the other." Should these candles fail to work at first, examine the insulation, determine if the induction coil is in good condition, and see where the current leaks away.

If the directions given have been carefully followed the high-voltage current may be made to appear in the form of a useful spark at the tip of the candle "wick." It is always a good precaution to use shellac wherever a high-tension current is employed, as it is one of the most reliable insulating materials. The wooden portion of the candlestick should, for effect, be gilded and given a light coat of protecting shellac.

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TESTING DYNAMOS.

MISCELLANEOUS METHODS.

In the previous articles, the most largely used methods of testing dynamos were laid down. There are, however, a number of other methods, some of which are mere modifications of standard ones, in order to allow for the peculiarity of the construction of the dynamos, while others are radically different. Where the machine is very small indeed, the friction of any extraneous device is relatively so large and so difficult to estimate, that tests using such methods will be practically worthless.

One of the most convenient methods for testing the efficiency of a small machine, such as a fan motor, or indeed any machine up to ⅓ HP, is the following:

The machine is mounted with the ends of its armature shaft on the centers of a speed lathe, and is connected to the line center by the ordinary dog and face plate method. The armature being on the centers in the lathe, the field magnet is therefore free to revolve about it, and will naturally fall so that the heavier side will be the lowest. Weights should be attached to field magnets in such a way as to bring its center of gravity in the line of the shaft of the armature, and the position of this weight can be accurately enough estimated, by adjusting it until the field magnet will stay in any position, with reference to the armature shaft.

Such an arrangement is shown in Fig. 1, the tail-stock being removed so as to show it more clearly. If the added weight be of iron, care must be taken to so place it that it does not magnetically short-circuit the field magnet. Lead is the best material to use. Now, if the lathe be started up, the dynamo will begin to generate, and if the wires are connected, it may be loaded to its full capacity, and there will be a strong tendency of the field magnet to turn with the armature, so that it will be necessary to secure it in some way. If we can measure its tendency to turn and also the speed of the armature, we shall have the torque of the machine, from which we can readily calculate the input in horse power.

We may measure the speed by an ordinary speed-counter in the usual way, and the tendency to turn may be measured by the pull which the field magnet exerts. To this end, bolt a small flat lever to some part of the machine and connect it to a spring-balance, as shown, providing also a pointer and scale. From the under side of this arm there should be hung a rod, to the lower end of which is secured a flat disk, very much after the fashion of the weight pan on a set of heavy scales. This disk should be immersed in a circular vessel filled with water, as shown in Fig. 1.

The position of the balance should be adjustable, so that when the dynamo exerts any effort on the weight arm, the latter may be brought back to zero by lifting the spring balance. This may be conveniently arranged by a screw support, or if the machine is a very small one, by means of a cord passing through a pulley and attached to a tackle block. The distance to the point where the spring balance is attached, to the lever from the center of rotation of the system, should be accurately measured.

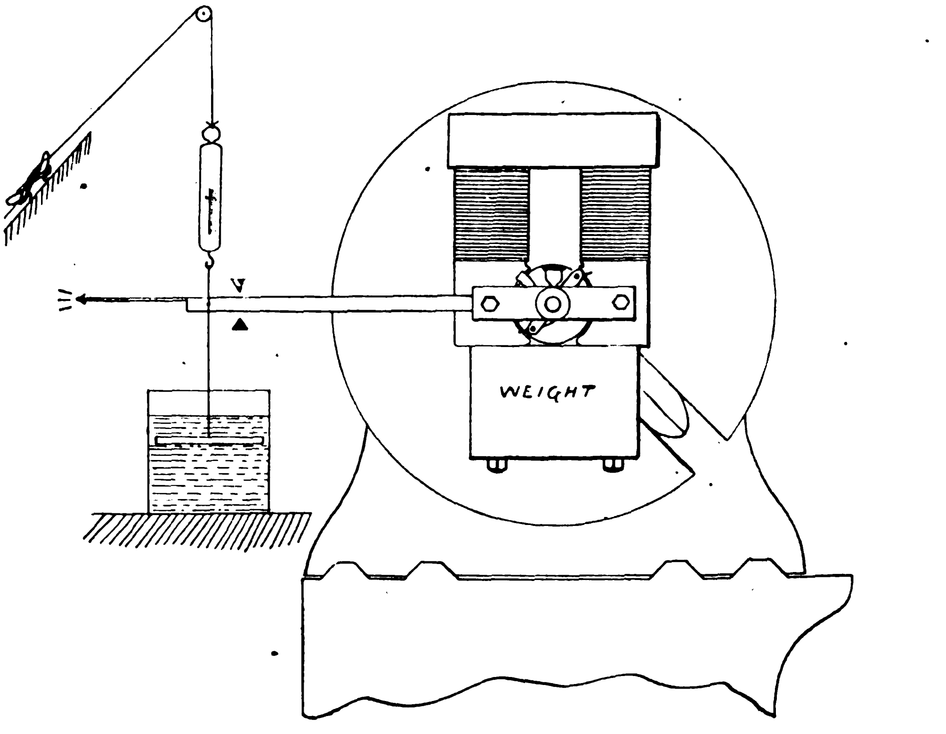


FIG. 1.—TESTING BY TORQUE METHOD.

This may be conveniently done if the lathe has a tool carriage, by placing a pointed tool in the tool post and adjusting the carriage so that the point of the tool is the same distance from the center, as the point to be measured. The carriage should now be longitudinally moved away, and the distance subsequently determined by tracing a light circle on piece of hard wood bolted to the face plate, and measuring the diameter of that circle and dividing by two. A lead pencil may be substituted for the pointed tool, if only soft wood is obtainable. To test the machine proceed as follows:

With the machine at rest, adjust the balance until the pointer of the arm is at zero, and take the reading; then start the machine and bring it up to full load conditions, and adjust the balance by the device provided till the point is at zero once more, and take the new reading of the balance. Measure the current and voltage that the machine is delivering, and having taken a sufficient number of readings for a check and general average, and accurately ascertained the speed, the observations are complete. It will be found that the action of the water dash-pot very much steadies the reading of the balance, without detracting from its accuracy.

The power the machine has received is equal to the pull exerted on the lever, multiplied by the number of feet per minute that the point on the arm to which the balance was attached would have traveled had it been free to turn with the armature. The pull is obviously equal to the difference of the balance readings, and the number of feet per minute is equal to 2π times the length of the balance arm in feet, times the number of r. p. m. We therefore have the foot-pounds per minute or $2\pi L N$, where L is the length of the balance arm, and N the number of r. p. m.; and if we divide this quantity by 33,000, we shall have the HP.

The HP output of a machine may be measured by the product of the volts and amperes divided by 746, and the ratio of the output to the input is the efficiency.

Another method of testing dynamos is illustrated in the diagram (Fig. 2). Its chief interest is its unique character, but the experience of the writer has been, that it is not a very accurate method and is a very troublesome one. The dynamo is surrounded by a box, which is constructed so as to be as nearly as possible an insulator of heat. It is therefore heavily battened with hair felt or woolen blankets. Two tubular entrances are provided in this box, one in the bottom on one side, and one in the top on another. The lower opening is connected by a system of piping to a blower, and thus air can be forced through the box.

The temperature of the air as it enters is taken by a thermometer piercing the pipe and as near to the entrance of the box as convenient, and in order that its indications shall truly represent the temperature, a system of vanes is provided, which is calculated to break up the currents and make the resulting temperature of the entering air more uniform. As it emerges from the upper opening, the temperature of the air is again taken by a thermometer, similar precautions being observed to break up the currents. The volume of air driven through the box is measured by an anemometer. The test is made as follows:

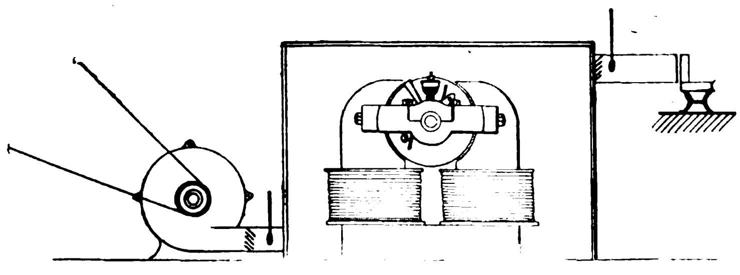


FIG. 2.—THERMAL TEST.

The dynamo is loaded and driven for several hours, until commercial conditions have been attained and the two thermometers have come to rest, the air being forced continuously through the box. The thermometers, the anemometer, the voltmeter and ammeter should now be simultaneously read eight or ten times, so as to get a reliable general average.

From the anemometer reading and the size of the outlet the number of cubic feet of air per minute that has been forced through the box can be calculated. The difference in temperature of the two thermometers shows the degrees the air has been raised, and if we multiply this by the specific heat of air and by the number of cubic feet heated per minute, we shall have the losses of the dynamo in heat units per minute. This gives all the losses. If the thermometers are Fahrenheit thermometers and the specific heat of air used assumes the cubic foot for a unit—that is, represents the quantity of heat necessary to raise 1 cu. ft. of air 1 deg. F.—the result will be in British thermal units, each one of which is equal to 778 ft. lbs. As the result of the observation will be obtained in the British thermal units per minute, it can be easily transformed into foot-pounds per minute, or horse power.

The losses being known and the output, the efficiency is calculated by dividing the output by the output plus the losses.

The specific heat of 1 cu. ft. of air may be taken at .0189 B. T. U., assuming a barometer pressure of 30 ins. Absolute accuracy would demand that this value be corrected, for temperature and existing barometer pressure, and similar corrections would have to be applied to the mechanical equivalent of work 778. The method as a whole is subject to greater inaccuracy than these corrections entail, so that applying them is like measuring distance with a clothes line with a micrometer attachment.

To take a concrete example, suppose that we are thus testing a 20-KW dynamo supplying 180 amperes at 110 volts, an output of 26.54-HP. Suppose that the delivery pipe was 0.25 sq. ft. in area and the anemometer registerd a velocity of 320 ft. per minute. Assume also that the difference in the thermometer readings was 60 degs., 80 cu. ft. of air were therefore forced through the box per minute, and the B. T. U. given to that air equals 80 × 60 × .0189 = 90.72 B. T. U. This is equal to 90 72 × 778 = 70580 ft. lbs. per minute = 2.14 HP, and the efficiency of the dynamo would be, 26.54 ÷ (26.54 + 2.14) = 92.5 per cent.

WORM GEARING AND RAILWAY TRACTION.

It is probable that the principle laid down in this article will be severely criticised, for it is a defense of the method of connecting railway motors to car axles by means of worm gearing. The worm gear is admitted by all engineers to be an uneconomical device, using a great deal of power, but present electric railway traction has demonstrated that there are other considerations besides those of efficiency, and it is the complete realization of these other considerations that makes the worm gear a type that will one day find a much larger use in the traction field.

Had the late Anthony Rackenzaun lived, it is highly probable that we would to-day be much nearer the use of worm gears than we are, for he was their most stalwart champion; his work remains, however, and will undoubtedly have its effect in the future.

The desiderata in a railway motor are: Powerful torque, noiseless operation, light weight, especially that part bearing on the car axle, small cost and low repair bills. Efficiency is a secondary consideration. To gain these other features and that of complete inclosure, the efficiency of railway motors has been sacrificed till it now seldom reaches over 85 per cent., and from that 10 per cent. is absorbed in the gears.

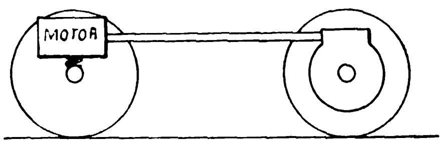
The first and most obvious advantage to be obtained by the use of worm gearing is the possibility of employing a motor of high speed as compared with present practice. High speed means great output with light weight, no matter what the motor. Nothing illustrates this more effectively than the steam turbine. A small steam turbine running at 20,000 r. p. m., having dimensions of less than 20 ins. in diameter and 5 ins. in thickness, can easily exert 15 or 20 HP; similarly, if we can employ a motor running at a high speed, we may expect a much lighter machine for the same power; in fact, with careful design we can almost cut the weight of the present motors in two.

The second advantage we obtain is the very light weight that bears directly on the axles. It is practically only that of the worm, the gear and their housings, which is about the same as the ordinary gear case of a modern motor—a mere fraction of the total weight that the axle supports. Fig. 1 will assist in understanding this. The motor itself can be placed at a considerable distance from the axle; in fact, in the case of a double truck, the motor driving one axle may rest directly over the other, but by a spring support to obviate rigid riding.

The next advantage is a commercial one. Small motors cost less than large ones, and if the money now expended on a large motor was put into one of smaller size and same power, driving a car by worm gearing, a much better motor could be produced. Wrought iron forgings could be afforded for field frames, laminated pole pieces could be used, and everything necessary to produce a strong field and hence a powerful torque. It is probable that the efficiency of the worm-gear motor could be raised to such a point that the tractive pull per ampere would not be such an unfavorable comparison with modern spur gears after all. The motor riding higher than its spur-gear competitors, will not be nearly so liable to be damaged by obstructions in the roadbed.

In action on the road this motor would have a number of advantages. As the worm gear is not a reversible combination, it follows that the car would stand still on a grade without a brake. If the car should get beyond control, it is simply necessary to pull down the trolley and the car would stop, for it could not coast down hill and drive the motor by means of the worm. A band brake applied to the motor shaft would stop the car with an effort that is trivial by comparison with ordinary braking methods; and if the device of short-circuiting the motors on themselves, or an adjustable resistance were used, it would hold the car under more complete control than the same device applied to modern motors.

A single disadvantage, aside from the inefficiency of the device, might be mentioned. If the motor should become disabled, it would be impossible to tow the car without detaching the worm gear from the car axle. This should not be a real difficulty, for ready means for liberating the car axle can be devised.



ARRANGEMENT OF WORM GEARING.

A serious problem in electric railway traction will find a solution in the worm gear. Heavy electric railroading demands motors of such size that they cannot be conveniently installed under the car floor, making recourse to the locomotive an absolute necessity. Two hundred HP seems to be about the limit of the size of motor that can be installed in double equipments on an ordinary bogie truck. The reduced size of the worm-gear motor will enable much more powerful equipments to be placed underneath the car floor, should future traction requirements demand.

The repair bill must be considered. Small motors are easier to repair than large ones and cost less, while in the matter of gearing the worm has another advantage, which is that the worm may be made of bronze, and the gear, which is the more expensive member, of steel; in fact some such combination would be necessary, for rubbing friction now takes the place of rolling friction. The worm has a better grip on its car wheel than a pinion, for it can bear against more teeth, and thus a softer metal will endure, where it would be entirely inadmissible in spur gearing.

It seems to the writer that these advantages are those which are eagerly sought by every railway designer, and for which he has been ever ready to sacrifice a few per cent. in efficiency.

The stock argument that the worm gear has been tried and has not proven satisfactory, is not a valid one. Single-reduction was tried and abandoned in favor of double-reduction, and after a time it again became, first popular and then universal. The worm gear holds out too many advantages to the designer of street railway motors to be relegated to the realms of unsuccessful devices. It will, doubtless, presently be brought forth again, exhaustively tried and, the writer ventures to predict, will succeed. The practical disadvantages which have been urged against it are short life of the worm and great friction. The same argument could be used against the screw and nut for continuously operating mechanical devices, yet Mr. F. J. Sprague boldly solved the problem by a ball-bearing screw. Rolling friction in the case in hand is not an inconceivable device, and it has not yet appeared that it is necessary in worm gearing, for practically no attempts have been made to develop the efficiency of that mechanism.

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AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

BRANCH TERMINAL MULTIPLE BOARDS.

As was pointed out in the last article, the series arrangement of jacks in multiple switch-boards is subject to grave defects, and does not represent the best practice in telephone exchange working of to-day. The branch terminal system was designed to remedy the defects inherent in the series system and possesses many advantages over it, chief among which are the facts that when a connection is made with any line the balance of that line is in nowise affected, and that the liability of open contacts in the jacks, which is such a serious defect in the series system, does not exist. The branch terminal system, moreover, lends itself more readily to the use of self-restoring drops, as will be described later.

In Fig. 1 is represented one type of the branch terminal system, sometimes called the three-wire system. In this figure three distinct line circuits are shown passing through three sections of board. The wires, k and k', of each line have branch wires leading off to a jack on each board; the branches from wire, k, leading to the contact thimbles, f, and the branches from wire, k', leading to the short springs, c, in the same jacks. Bridged across the two wires of each line is the line coil, n', of the individual annunciator belonging to that line. This coil is high wound in order that it may be left permanently bridged across the line without materially affecting the efficiency of the system in talking.

A third wire, t, passes through the board in parallel with each line. From this wire branch wires are run to the test thimble, g, and to the spring, b', in each jack belonging to that line. The test wire, t, after passing through all of the boards, runs through a low-resistance coil, n_2, on the drop of the line to which that particular test wire belongs, and then passes to ground through a battery, o, common to all test wires. These test wires are represented by dotted line in the figure in order to distinguish them more readily from the line wires. The remaining spring, b, in each jack is permanently connected to a ground wire, G, common to all of the jacks.

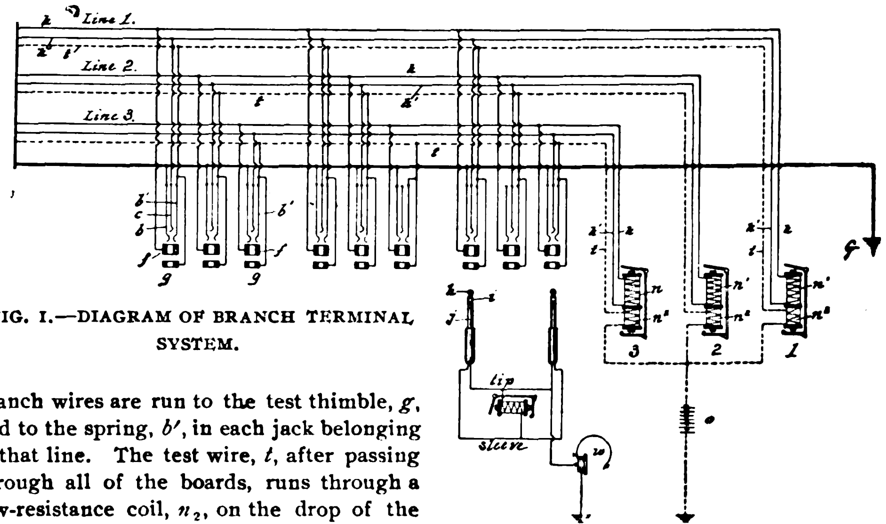


FIG. 1.—DIAGRAM OF BRANCH TERMINAL SYSTEM.

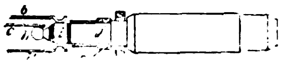


FIG. 2.—PLUG AND JACK.

Each plug in this system is provided with two contacts, h and j, which form terminals respectively of the sleeve and tip strands of the cord circuit. The tip, h, registers with the spring, c, when the plug is inserted into the jack (see Fig. 2), and the sleeve, j, registers with thimble, f. A conducting ring, i, entirely insulated from all other portions of the plug, registers with the springs, b and b', in the jack, and connects them together electrically.

Three general results are accomplished by the insertion of a plug into a jack. The tip and sleeve strands of the cord circuit are connected respectively with the sides, k' and k, of the line, thus continuing the line circuit to the cord circuit. The connecting of springs, b and b', by the ring, i, completes the circuit of the battery, o, through the restoring coil, n_2, of the annunciator, to the ground wire, G, and thus allows current from this battery to energise the coil, n_2, and restores the shutter of the annunciator. Lastly, the connecting of springs, b and b', by the ring, i, connects the test thimble, g, to ground by a short circuit, so that when an operator at any other board touches the test thimble of that line with the tip of her plug, a certain signal is given so that she may know whether the line is free or not.

The test in the particular system shown differs from that described in the last article in that a click on testing indicates a free condition of the line, silence, on the other hand, indicating that the line is busy. In the normal or idle condition of a line, the test ring, g, is electrified to a difference of potential from the earth by the battery o, which finds circuit through the restoring coil n_2, of the annunciator of that line to all the different test rings, g, belonging to that line at all of the sections of the board. If when the line is in that condition the tip of the test plug, which is grounded through the operator's receiver, be applied to the test ring, the circuit will be completed from the test ring touched to the operator's telephone and thence to earth, as is clearly illustrated in the diagram.

At each application of the tip of the plug to the test ring, a click will be produced in the operator's telephone receiver, indicating to her that that line is free and that the plug may be inserted. When, however, the line has been put into use by the insertion of a plug into the spring jack thereof, the springs, b and b', are crossed together by the contact ring, i, carried on the plug, whereby all the test thimbles, g, belonging to that line are connected directly to earth through a short circuit, and therefore no difference of potential exists between them and the earth. Thus, when a test is made on a spring jack of that line there will be no flow of current through the operator's receiver to ground, and silence will be the result. The operator then inserts the plug with which she has been making the test into the spring jack of the line tested, and the connection between the two subscribers is completed.

Fig. 1 is stripped of all unnecessary detail in order to enable the general underlying principles to be more readily grasped. In Fig. 3 the same system is shown more in detail as to circuits, connections and apparatus. Fig. 1 will give the reader a better understanding of how the jacks are grouped into sections, and of the relative location of the parts, while Fig. 3 will enable a better study of the circuits.

In this figure two subscribers, 1 and 2, are shown connected by line wires, k and k', with the exchange. Jacks, l and l', at sections 1 and 2 of the board, are shown in connection to the line leading from Station 1. Jacks, l^2 and l^3, are shown connected at the same sections with the line leading from Station 2. In the line leading from Station 1 is bridged the line coil, n', of the annunciator, this annunciator being placed at Section 2 of the board. The line coil of the annunciator of line 2 is similarly bridged across the two sides of the line, and is placed at section 1 of the board. A little study will show that the circuit of the line wires and the test wires are the same in Figs. 1 and 3, although represented in an entirely different manner. Like letters correspond to like parts in these two figures.

Two pairs of connecting plugs and their accessory appliances are shown complete, one at each section of the switch-board. The tips of the two plugs of a pair are connected together by one of the conductors, q, of the flexible cord, and the sleeves, j, are likewise connected by the conductor, q', of the same cord. Included in circuit between the two plugs of a pair are two callings, r and r', each adapted to disconnect both contact pieces of one of the plugs from those of the other, and to connect them to the wires, s and s', which form the terminal of the calling generator, *P. G.*

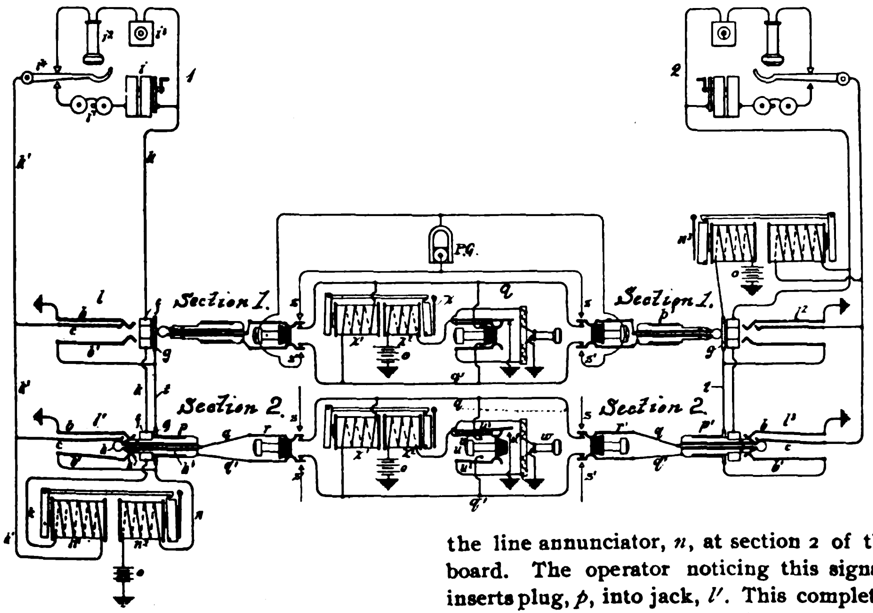


FIG. 3.—DETAILS OF BRANCH TERMINAL SYSTEM.

A listening key, u, is provided for each cord circuit, having contact points or anvils connected with the conductors, q and q', as shown, and having its contact spring, u', and u_2, connected with the terminals of the operator's telephone, w. When the plunger of the listening key, u, is allowed to rise, the operator's telephone is connected in a bridge across the two sides of the cord circuit, as is shown at section 1. A wire is connected from the middle point of the coil of the operator's telephone receiver to ground, so that when a test is made of any line, as was described above, a circuit will be completed from the contact thimble, g, of the jack through the tip strand, q, of the cord circuit, and thence through one-half of the operator's receiver coil to the ground. As this wire leads from the center part of the operator's receiver coil, it may be left connected permanently, as it does not destroy the balance of the line.

A clearing-out annunciator, x, similar in construction to the line annunciator, has its high-resistance coil, x', bridged permanently across the two sides of each cord circuit. The restoring coil, x^2, is connected in a normally open local circuit, including the battery, o, and terminating in the ground on one side, and in a spring, u^3, on the other. This spring, u^3, is arranged in conjunction with the listening key in such a manner that when the key is raised, the spring will make contact with a grounded anvil, d. Thus, whenever the operator listens in on any cord circuit she at the same time restores the clearing out drop if it happens to be down.

In order to give the reader a clearer understanding of the system so far described, it will be well to follow the operation in connecting one subscriber with another. Suppose subscriber 1 desires connection with subscriber 2. He operates his generator, i, and the current therefrom passes over the ine wires, k k', and through the coil, n', of the line annunciator, n, at section 2 of the board. The operator noticing this signal, inserts plug, p, into jack, l'. This completes the circuit from from ground, through battery, o, coil, n^2, of the line annunciator, thence to spring, b', through the ring, i, on the plug to spring, b, and to ground. The front armature of the annunciator is therefore attracted and the drop restored.

The operator then connects her telephone across the cord circuit by raising the key, u, and communicates with subscriber No. 1 in order to scertain his wishes. Having found that he desires a connection with subscriber No. 2 she takes up plug, p', of the same pair and tests to find out whether line No. 2 is not connected to at some other board. If it is not, a current will pass from battery, o, to the test ring, g, on jack, l^3, thence through the tip strand of the cord and through one-half of the coil in the operator's receiver, to ground. This will produce a click, which will indicate to her that the line is free. She then thrusts the plug entirely into the jack, in which position it is shown in the figure, and depresses the key, r', in order to throw current from generator P. G. upon the line of subscriber No. 2.

The two subscribers are now connected for conversation. When either rings off the current passes through the coil, x', bridged across the cord circuit, and actuates the clearing-out drop. The operator, noticing this, again listens in, by raising the key, u, in order to find out whether they are through talking, or whether one of them desires another connection. The act of listening in closes spring, u^3, against anvil, d, and thus restores the shutter of the clearing-out drop. If the subscribers have finished talking, the plugs are removed and placed in their normal resting place.

If, while subscribers 1 and 2 were connected together at section 2, as above described, some one at section 1 had desired connection with, say, line No. 2, the operator at section 1 in applying the tip of her plug, p^2, to the test thimble, g, as shown, would receive no click in her receiver for the reason as pointed out above, that contact, g, is connected to the ground by a short circuit by the plug inserted in jack, l^3. No difference of potential would, therefore, exist between thimble, g, and the ground, and hence no current from the battery, o, would pass through the télephone of the operator making the test.

* * *

VALVE GEARS.

Ever since the first steam engine was built, engineers have met difficulties in getting steam into and out of the cylinder to suit them. To construct a valve gear which will give a perfect distribution of steam and not contain mechanical defects, has proved a very hard problem.

The first steam engine had no valve gear. A boy opened and closed the valves as nearly as he could at the right time, and in providing this sort of a "ready-made valve rigging" the early engine builders escaped a good deal of trouble and worry. It was only after the lazy boy, in order to have more time for play, attached the valve cords to portions of the mechanism which moved in right direction at the right time—it was only then that the woes of the engine builders commenced.

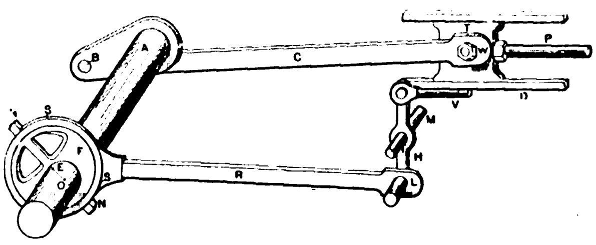


FIG. 1.—THE PLAIN SLIDE-VALVE GEAR.

Then they had to design a valve gear, and the more they designed, the more obstacles came more than half way to meet them. Probably the first attempt was the locating of a center and the forming of another crank on the main shaft for the purpose of operating the valve. This called for two cranks, and evolution enlarged the valve crank-pin until it would slip on over the shaft, thus forming an eccentric, instead of a crank, somewhat as shown in Fig. 1.

This diagram shows about all there is to a plain slide-valve gear. The rocker arm is not necessary except to bring the valve connection into the plane or level of the shaft. The great objection to this form of gear, aside from the trouble of obtaining an economical cut-off and consequent expansion of the steam, lies in the angularity of the connecting rod and valve stem, which, if less than forty times the eccentricity, will so distort the movements of valve and piston, that steam cannot be cut-off at the same point during both the out stroke and the return stroke of the piston.

A valve rod could be made 80 ins. long for an engine of 12-in. stroke, but how would the builder manage to arrange a connecting rod 20 ft. long? That problem has not been solved yet, and therefore the angularity of the rod and stem still disturbs steam distribution in our engines.

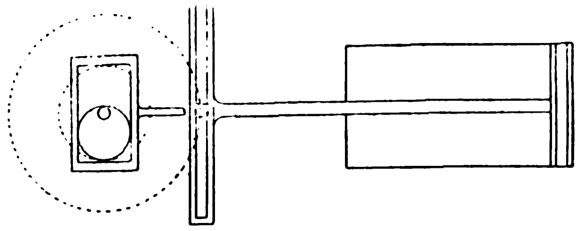


FIG. 2.—A PERFECT MOVEMENT GEAR.

There is a way whereby the above noted errors can be obviated, and that is by the use of the slotted cross-head, as illustrated by Fig. 2. With this form of connection, the valve can be made to cut off at half stroke, at both ends—something which the ordinary slide valve will not do, owing to the angularity of the rod.

A much more modern, and a better rig also, is illustrated by Fig. 3. This is the typical wheel-governor valve gear, with the exception that this shows still another variation from the average, in that the valve contains a cut-off inside, which is operated by a twisting action of the valve stem through the action of the governor.

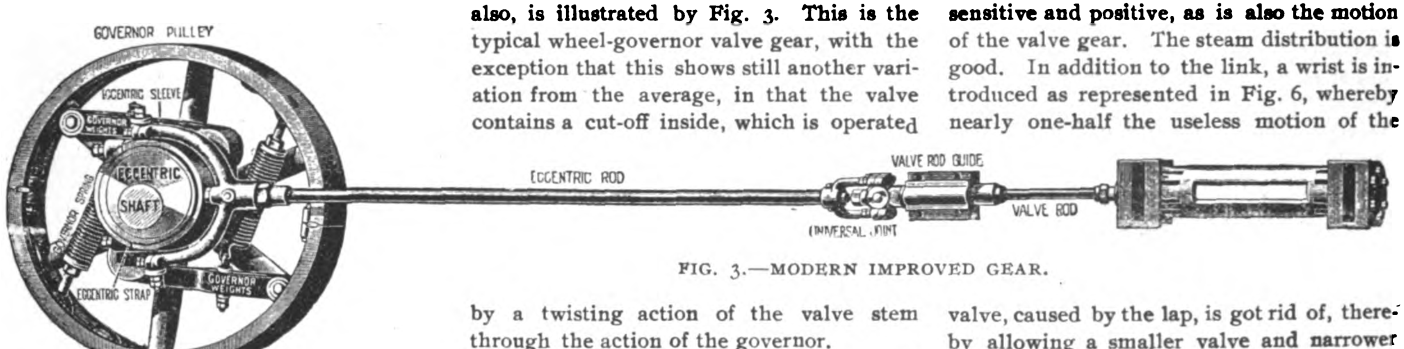


FIG. 3.—MODERN IMPROVED GEAR.

The link motion shown by Fig. 4 is still the most common form of valve gear in use when the engine must reverse. It is merely two eccentrics so set that one will drive the engine ahead, the other drive it backwards. By shifting either the link or the block, the engine is driven either forwards or backwards, at will. Cutting-off is done by shortening the stroke of the valve, which takes place as the block is placed in a central position, as in the engraving. Then there is little movement of the valve in either direction; hence the engine cannot run at any speed.

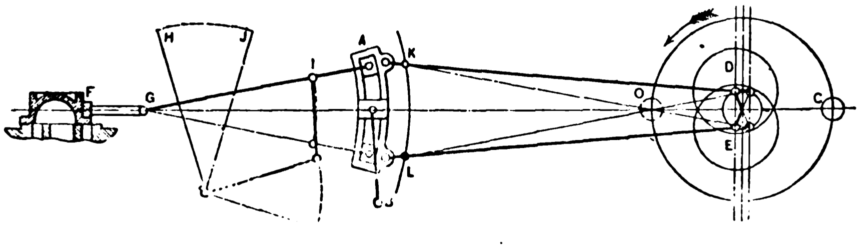


FIG. 4.—ACTION OF THE LINK.

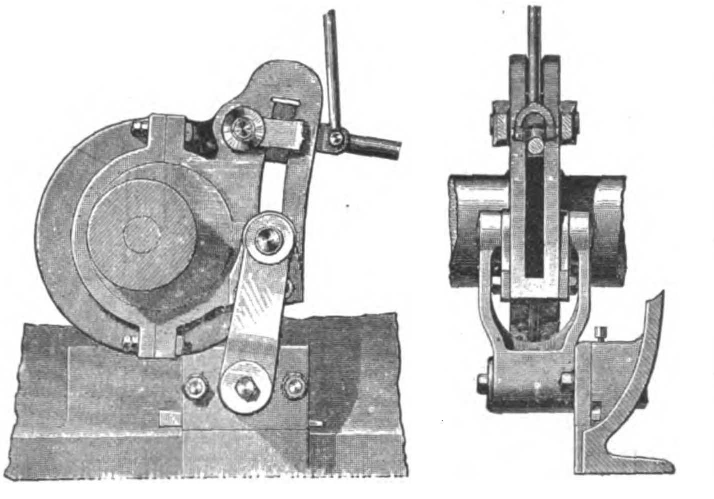


FIG. 5.—A POSITIVE, EQUAL-MOTION GEAR.

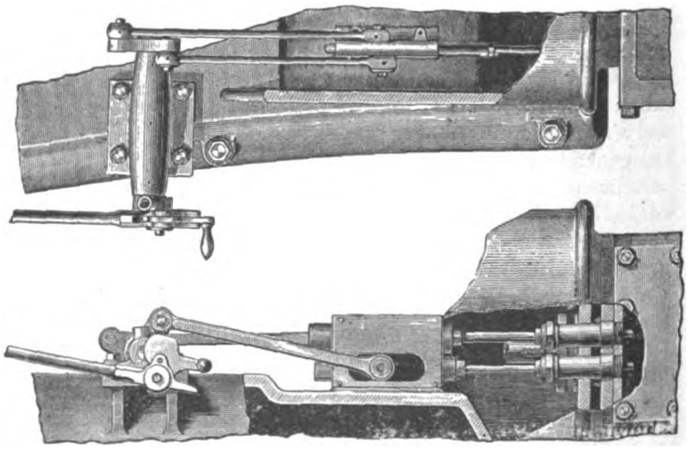


FIG. 6.—DIFFERENTIAL MOVEMENT FOR CUT-OFF.

In this form of valve gear, complications arise in connection with the angularity of the rods, and the lead of the eccentrics. But the shifting link has been applied to counteract the error in distribution occasioned by the angularity of the rod, etc. In the form shown by Fig. 5, it was applied to the first of the modern high-speed engines, and used in connection with four valves to the same cylinder, an efficiency was obtained approximating that of the Corliss-engine form of distribution.

In the engraving, the position of the link shown is adjusted by the direct action of a very heavy governor, which is possessed of great power through its weight and high rotative speed, thus making the governing sensitive and positive, as is also the motion of the valve gear. The steam distribution is good. In addition to the link, a wrist is introduced as represented in Fig. 6, whereby nearly one-half the useless motion of the valve, caused by the lap, is got rid of, thereby allowing a smaller valve and narrower seats.

The valve is driven positively, with uniform precision on both strokes, making it impossible for any irregular motion to occur, and the velocity of the closing, as well as the opening of the valves, increases directly with the speed of the engine. It will be noted that a detaching valve—like that of the Corliss type, for instance—would close no quicker when the engine was running 100 r. p. m., than when it was running at 50. The later the cut-off, the swifter the motion of the valve, and the quicker it closes—something not accomplished by almost any other valve actuated by a single eccentric. Not only is this valve thus actuated, but the cut-off is also worked by the same eccentric also.

Provision is also made for detecting and stopping any leakage, and the valves can be adjusted and made tight whenever necessary. A peculiarity of this valve gear is that it secures, at the end of each stroke, a compression that completely fills the end clearance in the cylinder, no matter what power the engine may be called upon to develop. Considered from all points, this valve gear is one of the most, if not *the* most remarkable in use upon steam engines.

A modification of this gear, using the same link and governor, is shown by Fig. 7. The end sought here is to apply the movement already described, to the operation of ordinary rotary valves of the Corliss type, whereby separate valves at each "corner" of the cylinder may be operated with all their own advantages, together with those of the positive distribution which have been described above.

By the action of the forked levers seen at the right of the engraving, and marked W_1, the valves are made to suddenly catch and spring open, closing again immediately, in something of the same manner that a snap switch used for turning on electric lights, is worked. In both, much the same action is followed: The pressure is put on the valve or switch, as the case may be, and the action takes place in an instant, doing all the work quickly, and lost motion during the rest of the movement caused by the eccentric, serves to let the lever follow the movement of the valve rod, and be in position to make another snap movement of the valve at the instant demanded by the governor.

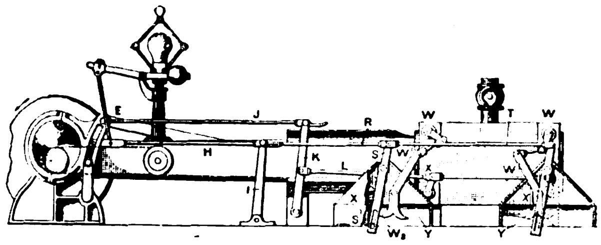


FIG. 7.—EQUAL CUT-OFF WITH CORLISS VALVES.

* * *

English Conservatism.

The question, Are tramways a nuisance? is not, an English mechanical contemporary ventures to think, an unnecessary one. Nearly every cyclist—if not all—would vote, it says, for their abolition if possible, and most of those who have carriages would do the same. As an example of the evils entailed, it is related that "the other day the Earl and Countess Spencer had a narrow escape, by the wheel of their carrirge being forced off by fowling the tram lines when being driven into Northampton." This incident, it appears, has aroused British public opinion, which asks, "what will be the chances of a safe journey through our streets when they have a network of overhead wires, together with their supports." Our contemporary adds that one way out of the difficulty is that offered by the motor car, "which is quite independent of rails, carries its own supply of energy, and is consequently independent of the trolley wire." It is not surprising that among a people so conservative, when the electric railway is by the force of circumstances imposed upon them, their engine and dynamo builders are found unequal to the occasion, and the greatest export machinery manufacturing country in the world has to send to America for its power house equipments.

LESSONS IN PRACTICAL ELECTRICITY

INDUCTANCE AND CAPACITY.

To illustrate the principles relating to inductance and capacity developed in the several preceding lessons, some problems will be solved which are not without practical interest. Indeed, we know of nothing that would be more instructive to those interested in alternating currents, particularly central-station superintendents, than to make an apparatus after the indications that will be given in this and the following article. Besides being instructive, such an apparatus would make an excellent exhibition piece, for to the lay mind most striking paradoxes would be presented in the various combinations that may be made with it.

It will be assumed that we have access to a 100-volt, alternating-current circuit with a frequency of 133, or about 16,000 alternations per minute. In a given case the frequency may be obtained exactly by taking the speed of the alternator; the number of r. p. m. found, multiplied by the number of poles, will give the number of alternations, and these reduced to one second and divided by two will give the frequency.

In Fig. 1, a 50-volt incandescent lamp is shown in series with an inductance, consisting of an iron core wound with wire. If the lamp is of 50-watt efficiency at normal voltage, it will take 1 ampere at normal candle power, and from Ohm's law we see that this corresponds to a lamp resistance of 50 ohms. Assuming that .7 ampere flows in the circuit, we will proceed to calulate the value of the inductance.

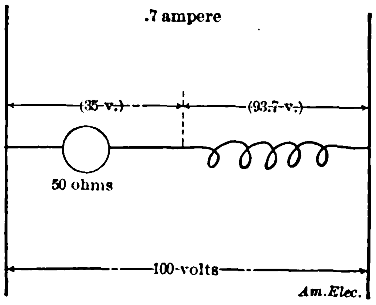


FIG. 1.—LAMP AND INDUCTANCE IN SERIES.

Since .7 ampere is flowing, this will produce a drop of $.7 \times 50 = 35$ volts in the lamp.

Referring to our inductance triangle (Fig. 2), $B\,O$ is the free E. M. F. just calculated, and $A\,B$ the impressed E. M. F. or the voltage of the circuit. Therefore, $A\,O$ or the inductive E. M. F., is $(100)^2 - (35) = (93.7)^2$ volts. Instead of assuming the current, a voltmeter might have been connected across the terminals of the inductance, which would at once have given the inductive voltage of 93.7 above calculated.

To find the value of inductance in henrys corresponding to the above E. M. F., we divide 93.7, first by $\frac{\pi}{2}$, in order, as explained previously, to bring the sine-wave alternating current to the terms of a uniformly varying current; second, since there are $4\,n$ variations per second, we further divide by 4×133; third, since the current is .7 amp. while the definition of the henry refers to 1 ampere, we divide finally by .7. Performing these various operations, we get for the value of inductance, .160 henrys.

The same result might have been obtained by substitution in the formula $E = 2\,\pi\,n\,L\,C$, where n is the frequency, L the henrys, C the current and E the inductive E. M. F.; or by substitution in the formula

$$E = \frac{2\,\pi\,n\,L\,C}{1000} \qquad (1)$$

if we wish the result to be in millihenrys or thousandths or a henry. As inductances usually are smaller than a henry, we will adopt the latter formula, which gives us the value of 160 millihenrys.

Taking up capacity, Fig. 3 represents a 50-volt lamp in series with a condenser on a 100-volt alternating circuit having a frequency of 133, the current flowing being 4 ampere.

Proceeding as before, the free E. M. F. will be $.4 \times 50 = 20$ volts, and we find from our capacity triangle (Fig. 4), that the capacity E. M. F., $o\,a$, is 98 volts. As in the previous case, instead of assuming the current, a voltmeter might have been placed across the terminals of the condenser, in which case the voltage of 98 would have been obtained direct.

We will obtain the capacity of the condenser in terms of microfarads, which is the commercial unit, there being 1,000,000 microfarads to the farad. That is, 1 ampere in one second would charge a microfarad condenser to 1,000,000 volts.

As the current is alternating, to reduce it to the terms of a uniform current we must multiply .4, as explained in a previous article, by $\frac{2}{\pi}$; second, as there are $4\,n$, or 4×133 charges and discharges per second, $1{,}000{,}000 \times .4 \times \frac{2}{\pi}$ must be divided by this quantity; third, as the capacity voltage is 98 and not unity, as required by the definition of the microfarad, a further division by 98 must be made. Performing these operations we find the capacity of the condenser to be 4.88 microfarads.

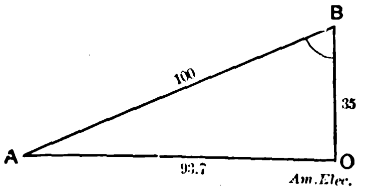


FIG. 2.—INDUCTANCE TRIANGLE.

This result could have been arrived at direct by substitution in the formula

$$E = \frac{1{,}000{,}000\,C}{2\pi\,n\,K}, \qquad (2)$$

in which K, is the capacity of the condenser, E, is the inductive E. M. F., C the current, and n the frequency.

The capacity above found is somewhat large to produce, requiring about 700 sheets of tin-foil 6 ins. square. The inductance is also somewhat large, requiring possibly in the neighborhood of 1500 turns of conductor on a core, 1 in. in diameter, of soft-iron wire.

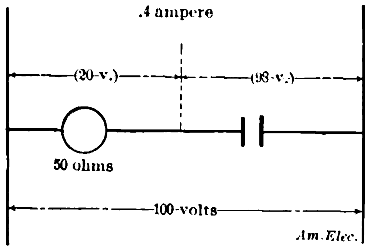
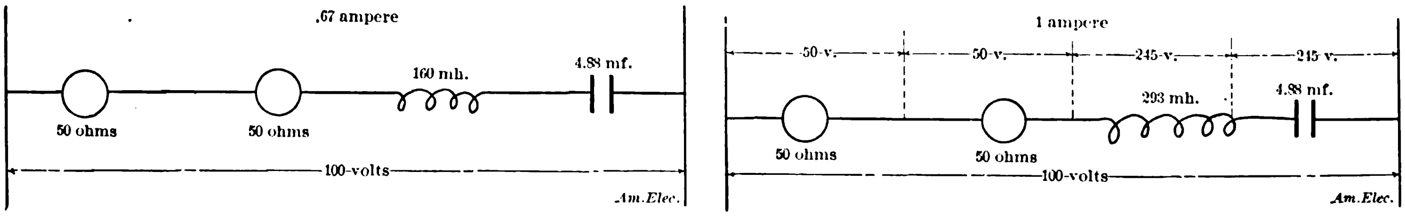


FIG. 3.—LAMP AND CONDENSER IN SERIES.

We will now see the effect of placing two 50-volt lamps in series with both the above inductance and capacity, as shown in Fig. 5. Assuming that 1 ampere flows, the drop through the two lamps in series will be 100 volts, which will be the perpendicular in the triangle (Fig. 6). The inductive E. M. F. for 1 ampere may be found by substituting in formula (1); or it will be greater than in the case of Fig. 1 in proportion to the currents, or as 1 : .7; calculating by either of these methods, we find that the inductive E. M. F. will be 134 volts.

Similarly, the capacity E. M. F. for 1 ampere may be found from formula (2); or it will be greater than the 98 volts found in the case of Fig. 2, in proportion to the respective currents or, as 1 : .4. Calculating by either of these methods, we find that the capacity E. M. F. will be 245 volts.



FIGS. 5 AND 8.—TWO LAMPS, INDUCTANCE AND CONDENSER IN SERIES.

It has previously been shown that the E. M. F. generated in a condenser is directly opposed to the E. M. F. generated in an inductance. In Fig. 6, if *oO*, represents the capacity E. M. F., we subtract from it *AO*, the inductive E. M. F., which gives a resultant of *oA* or 111 volts. Solving the triangle which results, we find that the impressed E. M. F. is 149 volts. The voltage of the given circuit, however, is only 100 volts, and therefore the current passing through it will be reduced in the proportion 144 : 100, and will therefore be .67 ampere.

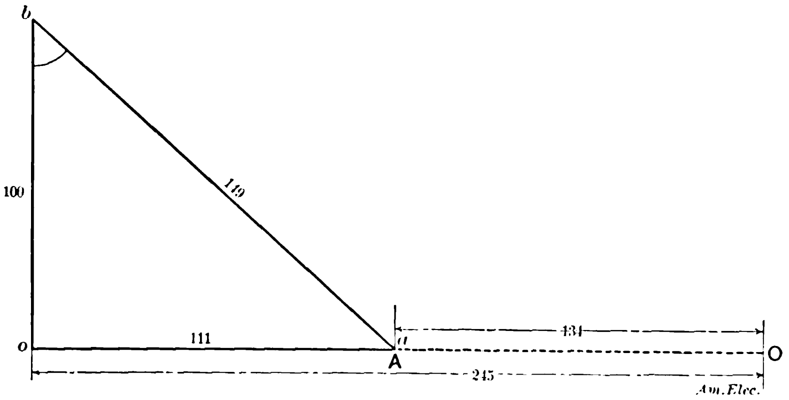


FIG. 6.—INDUCTANCE AND CAPACITY DIAGRAMS.

That is to say, with two lamps, the inductance and capacity all in series, the current flowing (.67 ampere), will be very little less than in the case of one lamp and the inductance in series (.7 ampere), and considerably more than in the case of one lamp and the condenser in series (.4 ampere).

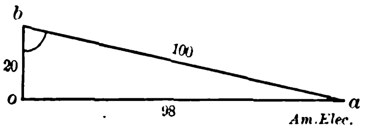


FIG. 4.—CAPACITY TRIANGLE.

It will be seen that this follows from the fact that part of the capacity E. M. F. opposing the impressed E. M. F. in Fig. 4, is nullified by the inductance. If the inductance were the greater factor, then part of its E. M. F. would be nullified by the capacity, the difference being that in the first case the current leads the impressed E. M. F. and in the second case it lags behind this E. M. F. It will thus be seen that if the inductance and capacity are such that one directly neutralizes the other, the circuit will act as if neither was present in it. We will illustrate this by an example.

In Fig. 7, suppose the inductance is such that if a voltmeter is placed across it the same voltage will be indicated as across the capacity in Fig. 2—that is 98 volts—when a current of .4 ampere flows.

The inductance corresponding to 98 volts may be calculated from formula (1) by submitting .4 for *C*, 98 for *E* and 133 for *n*; this gives us as the value of the inductance, 293 millihenrys.

Since now the inductance and capacity give the same E. M. F.—98 volts—for .4 ampere, they will also be equal for 1 ampere; and as they are opposite in direction the one will nullify the other.

Referring to Fig. 7, since the capacity and inductance are nullified, the current will flow which corresponds to the two 50-volt lamps in series on a 100-volt circuit, or 1 ampere. Since with .4 ampere the inductive and capacity E. M. Fs. are each 98 volts, for 1 ampere they will be increased in the proportion of 1 : .4, and will thus become each 245 volts.

We now have the very curious anomaly that whereas when a condenser and one lamp were in series on a 100-volt circuit, as in Fig. 2, only .4 ampere flowed; yet in Fig. 7 with two lamps and an inductance in series with the condenser, 1 ampere flows. The voltages in circuits are 50 volts for each lamp, 245 for the inductance and 245 for the capacity, the two latter, however, being nullified in the same manner that the E. M. F. of one series of primary cells placed in a circuit may be nullified by another series of cells of the same number, but connected in opposition.

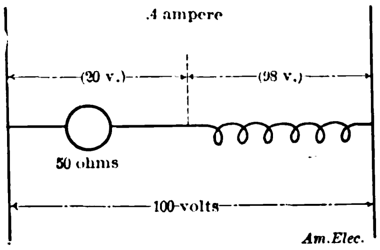


FIG. 7.—LAMP AND INDUCTANCE IN SERIES.

Some further paradoxes will be developed in a succeeding article on capacities and inductances in parallel. In the mean-time, should any reader having access to a 100-volt alternating current wish to construct an apparatus to show the above effects, he may do so from the following indications:

First, make as large a condenser as is practicable. If much smaller than the one above calculated, there will be the disadvantage that when in series with a single lamp the filament will not glow; in addition, the smaller the condenser, the greater stress will its insulation have to withstand. Having made the condenser, place it in series across the alternating-current circuit with two 50-volt incandescent lamps, and with a trial inductance coil. The latter may be constructed by winding, say, No. 18 to No. 22 wire on a core, 1 in. in diameter made up of soft-iron wire. For a coil of 300 mh. not far from 2000 turns of wire will be needed.

With an alternating-current voltmeter measure the voltage acoss the terminals of the coil and also across the terminals of the condenser. If the former voltage is greater or less than the latter, add or substract turns from the coils until the voltages are equal.

In all the above cases, the resistance of the inductance coil has not been taken into consideration, for the reason that in any practical case it would only affect the value of the inductive E. M. F. by a fraction of a volt, and that of the lamp by only 3 or 4 volts, if No. 22 wire is used, and much less, of course, for No. 18 or 20 wire. This fact is of significance in showing how slight a factor ohmic resistance is in gas-lighting and induction coils, the drop from it being there usually entirely overshadowed by the inductive drop, so that the E. M. F. to apply depends practically on the inductance and not thetresistance.

Letters on Practical Subjects

One Way of Connecting up a Meter.

To the Editor of American Electrician:

Having run across a curious wiring combination, I thought it might interest some of your readers to know how lighting companies are sometimes cheated out of the proper amount of their bills by careless wiring and a lack of knowledge of electric circuits.

I had for some time thought that the bills for a certain hotel were too small for the amount of light that was being used, so I had the meter taken down and tested, but found that it registered correctly. I then began to look elsewhere for the trouble and found it. I discovered the building was being fed by a 100-light, three-point transformer, it having been installed shortly before I took charge of the company, and happened to be the only transformer of the kind in town.

This is where the trouble proved to be, for they had wired the house on two circuits, using the middle leg of the transformer as a common return for the two, and had placed the meter, which was an ampere-hour instrument, on this middle leg.

Taking the Edison three-wire system as an example, it is, of course, well known that if the system is evenly balanced by an equal number of lamps on each side, no current will flow over the middle or neutral wire; and if unbalanced, only that amount of current passes over it back to the dynamos, which is due to the difference in load on the two sides. In the case here mentioned, if the two circuits in the house had the same number of lights on each, there would have been no registration of the meter; but it so happened that the down-stairs circuit had the larger number, and the difference between the two was the amount registered. The remedy, of course, was to place a meter on each of the two outside legs.

Durango, Col. R. H. STERLING.

Principle of the Wheatstone Bridge.

To the Editor of American Electrician:

Your explanation of the principle of the Wheatstone bridge, in the December issue, impressed me as being very ingenious and easily understood. I recently had occasion to demonstrate the working of a bridge to a pupil who was especially hard to convince, and did not even see the matter clearly with your diagram before him. To make the matter still more plain to him, I connected an ammeter into each arm of the bridge, together with the resistances there marked, and he saw the actual indication of the passage of current as the several resistances determined their flow. He had no further trouble in understanding the matter. GEORGE EASTLAKE.

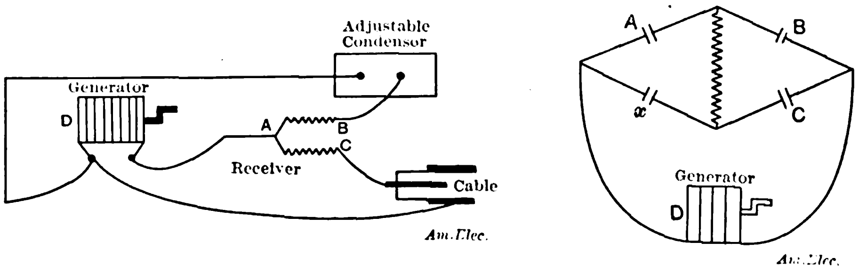
New Brighton, S. I.

Measuring Capacity.

To the Editor of American Electrician:

Would some of the readers of your valuable paper give their opinion as to the feasibility of the following scheme for measuring capacity. As I am not in possession of an adjustable condenser, I never had a chance to try it. The following instruments are needed: 1°. One telephone generator (or an alternating current). 2°. One telephone receiver with two coils of exactly equal resistance and ampere turns and highly insulated from each other. 3°. One adjustable condenser.

The two windings of the receiver are connected up so that no sound will be heard if the current strength from *A* to *B* (in Fig. 1) is the same as from *A* to *C*. It is evident that if you adjust the condenser so that no sound in the receiver is heard the reading on the adjustable condenser will show the capacity of the cable.



FIGS. 1 AND 2.—MEASURING CAPACITY.

I believe an arrangement similar to the Wheatstone bridge could be made, by substituting for the battery an alternating-current generator, and for the galvanometer a regular telephone receiver and condensers for the resistance coils. The connections are shown in Fig. 2, in which *A* represents the adjustable condenser; *x* is the unknown capacity; *B* and *C* are the "short arms" of the bridge—of course, also condensers; *R* is the telephone receiver and *D* is the electrical source. HENRY P. J. VAN DETH.

Montclair, N. J.

A Generating-Room Signal.

To the Editor of American Electrician:

In a certain isolated plant with which I at one time had a good deal to do, there are numerous circuits which carry very heavy loads. One of these supplies a very large auditorium which is most abundantly lighted —in fact, 1200 amperes are required for this purpose.

Unfortunately for the arrangements of the engineer, it is the proprietor's pleasure to go into this reception room at unseemly hours with parties of chosen friends, and throw all of the switches to exhibit the lighting of the hall—a natural enough desire in gratifying his personal pride, but one which creates consternation in the engine room whenever it is consummated. It was finally decided that some communication must be had with the engineer before inflicting him with a load of 240 HP without his knowledge, and a telephone was suggested. The necessity of this expense was averted, and a very much simpler device was substituted, which performed the office of notifying the engineer that it was desirable to have the auditorium lighted, without causing the slightest inconvenience to whomever turned on the lights in that apartment.

The circuit-breaker in the engine room which controlled that circuit was left open, and its jaws were bridged by a red incandescent lamp. The result of this is easily seen. When the proprietor's vanity was such that it required a little electrical display to tone it down, and he stepped into the auditorium and began to throw switches, the red lamp in the engine room would light, but the lights in the auditorium would not. The engineer seeing the light, knew that power was required on that circuit and could cast an eye about his station to see whether or no he had sufficient machines to meet the load, and having arranged matters to his satisfaction, could close the circuit in the usual manner. This device did not cost in toto more than $1, it can never get out of order or repair, and has proven so satisfactory, that I believe that some of your readers might like to apply it in similar places. R. L. BROWN.

New York.

Magneto for Firing Fuses.

To the Editor of American Electrician:

Referring to the letter from R. H. Sterling in the January issue, I wish to state that the method of connection and the form of switch illustrated with his letter, are the same as those used in the magneto described in my November letter, but it would not work. When the rack plunger was descending with the magneto short-circuited, it required a very great power to operate the instrument, the magneto seeming to be under a very great back-pressure, but when the switch was opened, the fuse would not go off.

The magneto seemed to be larger than that used in a similar machine with which I have exploded a dozen caps in series at once.

And it was a magneto, pure and simple, not a constant-current generator as Mr. Sterling describes. It was wound with No. 34 silk-covered wire, and seemingly the machine was as able to do the work as was the "store" machine, which was in daily use. Thus far, none of the replies to my November letter have helped me out.

I desire to thank Mr. A. W. Lee for the neat solution of the three-wire, two station circuit problem. His scheme for the control of lamps on a three-wire circuit fills the bill fully, as far as the requirements of the problem are concerned, but would the inspector of an insurance company permit the third wire to be run direct as in the sketch (January, page 38), and remain alive at all times, whether the lamps were in use or not?

It seems to me as if the inspectors would require that the third wire should run through the switches also, something which could doubtless be easily managed by using three instead of two-pole switches. I do not contend that this arrangement would be any better than the one given by Mr. Lee, which seems to do the work properly, but the inspectors require many things which practical people do not expect. They are in business for the elimination of possible risks, and all honor to their profession, but disgrace be the lot of the inspector who orders fool changes simply for the purpose of showing his authority.

Brooklyn, N. Y. JAMES L. FRANCIS.

Electrical Sport—Fun with the Boss.

To the Editor of American Electrician:

I note with interest the remarks of Mr. Jos. H. Smith, in regard to "Electrical Sport," and also notice his delicately implied hint to "take some one of your size." It is always the safest to use humble means for our fun, but if, as Mr. Smith intimates, the bigger the game, the greater the sport, he could probably have much more fun with the manager or superintendent, than with anybody else connected with his environment.

To "have some fun" with "the old man" it is only necessary to doctor one of the incandescent lamps in his office. Any broken lamp will do, the filament being carefully removed through a hole cut in one side of the globe. A piece of fine wire is carefully attached to the stubs of the filament connection, forming a wire loop in the globe. Let the wire loop be long enough to reach to the side of, and lie against the bottom part of the lamp globe when in place.

Put two or three teaspoonfuls of magnesium powder, such as used by photographers for taking flashlight pictures, in the lamp, and make sure that the wire loop lies in the powder when the lamp is in place in the Super's room. Rig an electro-magnet to a camera in such a manner that when the lamp is turned on, current will pass through the magnet, and spring the shutter of the camera. Place the camera on some convenient case or cabinet in the office, and focus it on the space a man would occupy when he is in the act of turning on the doctored lamp. If the camera can be outside the office, and command a view of the interior through some convenient hole, so much the better.

If carefully prepared, the apparatus noted above will secure a photo of the manager, in a most unstudied pose, and full of life and vigorous action. It might not be safe to immediately show the negative to the honored victim of our sportive proclivities unless some other situation was immediately desired. T. L. JOHNSTON.

Chicago, Ill.

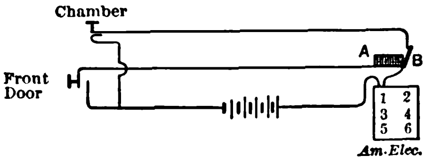
An Electric-Bell Arrangement.

To the Editor of American Electrician:

Here is something new to me, and perhaps may be of interest to your readers, as other things in your correspondence column have been to me.

A prominent physician in this town recently leased a house which was fitted with a six-point annunciator, which had been wired before the house had been lathed and plastered. The drops were connected as follows: Front door, side door, dining room, library, front chamber and north chamber.

Having frequent night calls, he was desirous of a bell in his chamber from the front door, but the owner of the house would allow no wire to be run. He, therefore, wished the annunciator push removed into his chamber and a bell attached to the wires and so arranged as to ring from the front door push.



ELECTRIC BELL ARRANGEMENT.

It was at first pronounced impossible, but I accomplished the result in the following manner:

A is a small coil with swinging armature; *B* is a pin to which the wire that formerly ran to No. 6 in annunciator is attached. When the front door push is pressed, *A* draws its armature to *B*, but the vibrator in the annunciator causes the armature of *A* to vibrate, as they are in series, which causes a current to flow to the bell substituted for the chamber push-way, but is broken as often as the vibrator in the annunciator acts. Thus with a single-stroke bell in the chamber, both annunciator and bell vibrate in unison. Five cells of battery only were required. ROY J. TOMPKINS.

Janesville, Wis.

Behavior of Dry Cells.

To the Editor of American Electrician:

Will some of your readers rise to explain the working of some dry batteries that behave as follows: They are of the Crosby type, and I have sixteen of them, and when attached to a voltmeter each gives a deflection of a trifle over 1 volt. When connected in series, eight will give only 5½ volts. I obtained the cells for the purpose of the experimental working of a new sysrem of duplex telegraphy, and working through a certain resistance with six cells, it was necessary to obtain twice the current.

To do this, I connected up twelve of the dry cells in series, but the experiment failed miserably. It was after this occurrence that I attached the voltmeter to eight of the cells, as above described. Can some one among your readers rise to explain this discrepancy? The connections between the cells are large No. 16 wire, and they are very short. The current from the eight cells is a little less than ½ ampere, and the current from a single cell is a trifle more than ½ ampere.

Philadelphia, Pa. N. T. JARVIS.

Electrical Sport.

To the Editor of American Electrician:

Some electrical sport which we have not seen mentioned in the AMERICAN ELECTRICIAN was tried by us some time ago with considerable success.

A large kerosene lamp was emptied of its contents, cleaned and fitted with an incandescent lamp. The whole was placed on a table in front of a parlor window, so as to appear as if it had been upset, the white shade concealing the incandescent lamp from view from the street. The concealed operator made and broke the circuit with a rapid, irregular motion, producing the effect of a flickering, sputtering kerosene lamp, perhaps about to explode.

An acquaintance of ours, passing by, saw it, and in evident alarm sprang to the door and, ringing the bell violently, hastened to apprise us of the danger. We had a good laugh at our friend's expense, who, however, joined in as soon as he understood the joke.

On another occasion, the same lamp was used temporarily to light a hall organ, where it was placed in an inverted position, producing at first sight a rather striking and ludicrous appearance.

Berkeley, Cal. CLARK BROTHERS.

Magnetizing Galvanometer Needles.

To the Editor of American Electrician:

In the description of the Thomson astatic galvanometer, as given in the January issue of this journal, I am impressed by the amount of apparatus made necessary for magnetizing the needle. The method there described seems to be to carry with it a large amount of mechanical (or electrical) "red tape," and I am at a loss to understand why a much more simple method would not answer equally as well as the elaborate one described, and illustrated by Fig. 12, page 28.

I will state that in magnetizing needles for several astatic galvanometers—in fact, for the same ones described elsewhere in this issue—I used a simple coil of No. 16 wire, containing about fifty turns. It was wound up for the occasion, upon a bit of ⅝-in. brass tubing which happened to be at hand. The needles were made in lengths of two, both the wire ones and those of steel tape, and before being hardened, were marked with a file pretty deeply where they were to be divided.

A number of pieces of iron wires were cut off—enough, in fact, to fill the brass tube. The pieces of wire were cut about 2 ins. longer than the steel for the needles, and the coil above described was slipped upon one end of the bundle of iron wires. The

LI . RY

pieces to be magnetized were laid lengthwise along the wire core, and current from a six-cell storage battery was turned into the coil and continued until the coil became pretty warm.

Before cutting off the current, the hardened steel pieces were one at a time slowly removed from the wire core, taking care to carry them away *sidewise* until at least 4 ft. from the core. In this manner, I obviated the necessity of exposing the magnetized steel to the lines of force of an opposite polarity which it must pass through if pulled off the core endwise. By taking the steel off before current was cut off, it was not exposed to the returning lines of force at the instant of breaking the current in the coil. I have given no thought to the technical analysis of this way of magnetizing needles, but I found that by breaking the steel where marked, two needles of mighty near the same power were obtained.

Brooklyn, N. Y. JAS. F. HOBART.

Brush Arc-Machine Controller.

To the Editor of American Electrician:

Mr. Jos. A. Maloney, chief engineer of the Mobile Light & Railway Company, recently called my attention to the erratic behavior of the ammeter on an arc circuit fed by a Brush machine, when the door of the controller of the machine is closed, as is intended, and to the steadiness of the current when the door is left ajar.

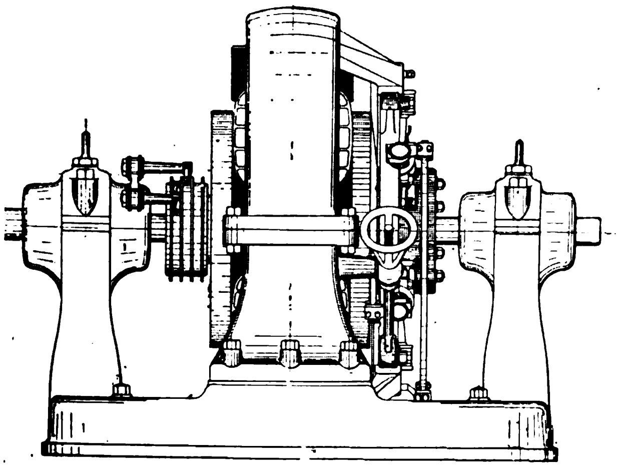


FIG. 1.—ROTARY TRANSFORMER.

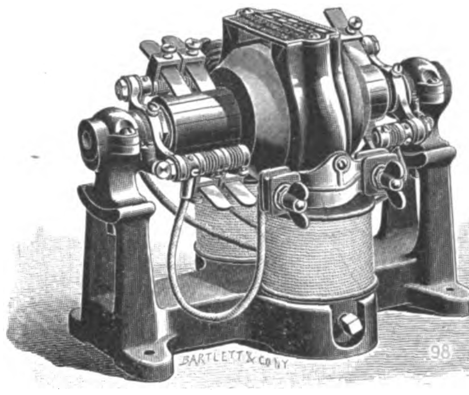
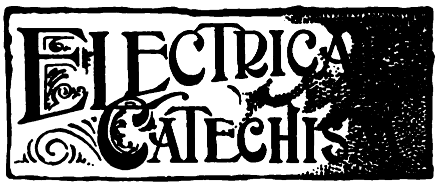


FIG. 2.—DYNAMOTOR.

This fluctuation of the current is no doubt due to the shunting of the magnetic lines of force in a greater or less degree away from the cores of the solenoids, thereby rendering the regulation defective. As is usual, this door is of comparatively heavy iron, as is the rest of the case. No doubt if the entire case was made from a non-magnetic material, the regulation would be almost perfect, as the back of the regulator must act upon the solenoids in a similar manner, being similarly placed.

I have never heard of just such another case, but mention it for the benefit of any engineer having similar trouble. Mr. Maloney discovered this fact shortly after the installation of the machine.

Mobile, Ala. REESE HUTCHINSON.



183. What is a rotary transformer?

A rotary transformer is a machine for changing an alternating current into a continuous current, or *vice versa*. It is practically a continuous-current motor with a set of collecting rings at one end like the rings of an alternator. If continuous current is supplied at the commutator, alternating current may be taken from the collecting rings. On the other hand, if the machine is supplied with alternating current at the rings, continuous current may be taken from the commutator. The machine is often supplied with a pulley so that it can be used as a motor to furnish power, or may be driven as a dynamo to generate either continuous or alternating current. Such a machine is illustrated in Fig. 1, in which the commutator for continuous current is seen between the field magnet and the bearing at the left, while the four collecting rings for taking off two-phase alternating current are seen at the left beyond the bearing.

184. What is the difference between a rotary transformer and a rotary converter?

These are simply two names for the same thing. They are often called simply "rotaries."

185. What is a motor-generator?

A rotary transformer might be called a motor-generator, but this term is usually applied to a machine having a double winding on its armature or having two armatures on the same shaft. These machines are generally designed to change from a continuous current at one voltage to a continuous current at another voltage.

186. What is a dynamotor?

Dynamotor is simply another name for a motor-generator. The shorter name is more commonly used. (See Fig. 2.)

187. For what purposes are dynamotors used?

Numbers of dynamotors are used in large telegraph offices for supplying currents at various voltages. One armature winding is designed for the 110-volt lighting circuit, while the other winding is suited to deliver current at one of the various voltages desired. Dynamotors are sometimes used to obtain current for incandescent lighting at 110 volts from a power circuit at 500 volts. Other machines are used for obtaining heavy current at low voltage, such as is required for electroplating or electrotyping, current for the motor end being taken from the regular circuit at 110 or 500 volts.

188. Is there not a great loss in changing the voltage by a dynamotor?

Not so much as one might at first think. In a moderately small machine, say of 10-KW capacity, the efficiency of the motor part will be about 90 per cent., and that of the dynamo end about the same. The combined efficiency of the combination will be the product, or 81 per cent. For example, if 10,000 watts be supplied at the motor, about 8100 watts may be obtained at the dynamo end.

189. When a dynamotor is used to reduce the voltage, is it possible to obtain a larger current from the dynamo end than is supplied at the motor end?

Yes. It is possible to take out a larger current than is supplied. This is possible because the larger current is at lower voltage than the current supplied. The power is the product of current by voltage, and these two might have any values so long as their product was less than that of the current and voltage supplied at the motor end. For example, suppose the motor takes 20 amperes at 500 volts; the power taken is 20 × 500 = 10,000 watts. The generator end might deliver 73.6 amperes at 110 volts, making a product of 8100 watts, or 81 per cent. of that furnished at the motor end.

190. What becomes of the difference between the 10,000 watts supplied and the 8100 watts delivered?

It is used up by unavoidable losses in the machine, such as friction at the bearings and brushes, heating in the armature wires due to their resistance, the current necessary for exciting the magnetic field, and heating of the armature core due to hysteresis and eddy currents in the iron.

QUERIES AND ANSWERS

NOTE.—*Only the queries of subscribers are answered, and must be accompanied with full name and address for identification.*

Can I run a $\frac{1}{12}$ HP motor as a dynamo? F. S.

It is rather doubtful if such a small machine will self-excite. Belt it and try; should it fail to excite, its field may be supplied with current from a battery.

What strength of spring is required for a 220-volt voltmeter? W. M. B.

The strength of sping depends entirely upon the magnetic field and the coil used, as it balances the force exerted between these; it may therefore vary from a hair spring to one comparatively strong.

In the answer to the query of D. B. in the January number, he is advised to rewind the field of a dynamo when halving its voltage. Could not the same result be obtained by throwing the fields in parallel, if the dynamo is a bipolar one? G. S.

Yes. The answer as given would only refer to a one-coil machine, or to a bipolar machine already connected in parallel.

I wish to get an artificial load for a three-phase, 4500-volt, star connected alternating-current generator. How can I construct a water rheostat or choke coil for this purpose? L. R.

See December issue for data of water rheostats. A choke-coil would merely introduce a back E. M. F. in circuit, the ohmic drop in its coils being the only load it would give.

Where can I procure small field steel castings from patterns, and stamped soft iron armature desks? J. N. L.

The former may be procured from the American Steel Casting Company, Thurlow, Pa., and the latter from the Cherry Electric Works, 27 Third Avenue, New York, or the Miamis Electric Company, Miamis, Conn.

1°. What is the commercial efficiency of the small motors described in the February and April issues? 2°. Has the strength of a coil any relation to its resistance? C. D.

1°. About 60 per cent. 2°. If the product of the amperes and turns of two similar coils are the same, their strength will be identical. Ampere-turns correspond to watts in the respect that the turns and current (like the volts and current) may be varied to any extent without change, provided the product remains the same.

What should be the dimensions of a 1½ in. spark induction coil, and how much secondary wire is necessary, using No. 33? H. K.

Use a core 6 ins. long, ¾ or 1 in. in diameter, and made of soft iron wire. There should be at least a half inch clearance between the secondary and primary. Use filter paper between the layers of secondary, wind loosely and surround with paraffine. If made according to indications given on page 18, January, 1897, issue, 1½ lbs. of No. 36, or 3 lbs. of No. 33, wire will be sufficient for the secondary. The old rule was 2 lbs. of No. 36 per inch of spark.

What is the trouble in a transmitter which makes the voice sound as though the speaker were talking through his nose? M. L. C.

A. The contacts of the instruments may partially break on the louder sounds, thus causing a sound similar to the one described. The diaphragm of the transmitter or of the receiver may not properly lend itself to the vibrations of the voice, having a fundamental tone of its own, slightly above the pitch of the human voice, which would probably produce the sound described. To correct for the latter defect, use a little thinner or softer diaphragm.

1°. What causes static electricity in belts, and is it liable to cause any damage to dynamos? 2°. In starting two direct-current machines, the polarity of one was changed. Is there any harm in running it as it is, and how may the original polarity be regained? D. A. B.

1°. The static electricity is caused by the friction of the belt on the pulley belt, and may puncture the insulation of the machine. It may be removed by a metal comb nearly in contact with belt and well grounded. 2°. No harm will result; the polarity may be charged by means of current from the other machine, the connections being made by trial, using a compass or magnetized piece of steel.

How may I make a 1-KW rotary converter to convert a 110 volt single-phased alternating current into a 110-volt direct current? G. A. C.

By connecting two rings to diametrically opposite segments of a continuous-current machine, you will have a single-phased rotary converter. The machine should be multipolar, as the speed will be the number of alternations divided by the number of poles. Such a converter, however, will have to be brought to synchronism by external means in starting. To obtain a continuous-current of 110 volts, the alternating current will have to be supplied to the rings at 77 volts, the ratio between the two voltages being fixed.

I have a 20-light Sperry type arc machine, and of late the flexible cord commutator lead wire burns off, generally near the bars, but once at the commutator. They burn off suddenly and while the machine is operating perfectly. What is the cause? J. S. J.

The back of the commutator is probably dirty and has a deposit of copper dust and oil which gradually accumulates until a section is short-circuited and the leads burn off. The leads should be much smaller in carrying capacity than the armature, so that they will burn off before the armature goes. In cases where the leads burn off near the armature, the deposit of dirt and copper may be anywhere between the commutator and armature.

What would you recommend as a systematic course in electrical reading for one who understands elementary algebra? K. S. P.

1°. Read Thompson's "Elementary Lessons in Electricity" to obtain a knowledge of principles. 2°. Next, take up Slingo & Brookers's "Electrical Engineering" to obtain a general view of the practical field. 3°. Finally, read Thompson's "Dynamo-Electric Machinery," after which the reader will be excellently prepared for special treatises, such as Wiener's "Practical Calculation of Dynamo-Electric Machinery," Bell's "Electrical Transmission of Power" and "Power Distribution for Electric Railways," Crocker's "Electric Lighting," Jackson's "Alternating Currents," etc.

Is it possible to use more bridged telephones on a metallic line than on a grounded line, the two being of the same length? M. L. C.

A. Theoretically it would be possible to use more bridged telephones on a grounded line than on a bridged line, as the resistance of a grounded line is but approximately one-half that of a metallic circuit line (the sizes of the wire being equal). But there is always some resistance in ground connections which will under ordinary circumstances about even the matter up. In practice, the noises from induced and earth currents on grounded lines make the talking qualities of the line much inferior to those of a metallic circuit line, and therefore the number of instruments which could be used in practice on a grounded line would not be so great.

1°. Please give the field and armature windings and construction of commutator for the motor of which a sketch is enclosed; what would be the capacity of this motor? 2°. What kind of a battery is suitable for running a small motor? E. L.

1°. See February and April issues, 1897, for construction of small motors, battery windings for which are given on page 358 of September, 1897, issue. We cannot undertake to furnish windings for amateur designs of fields. Of a score or more of the latter sent us, scarcely one has been of correct proportions. Besides, to send a drawing of a field and ask for windings, is like sending to an engine designer the drawing of a piston and ask for the design of the complete machine. 2°. The Gordon-Burnham and Edison-Lalande are closed circuit batteries. A powerful and cheaply constructed battery is described on page 324, August, 1897, issue.

How does a bridging generator for telephone service differ from a common series generator except in the way it is connected on the line? H. O.

A. A series generator should be designed to develop a small current at a rather high E. M. F. Its armature is therefore usually wound rather high—from 500 to 800 ohms. Bridging ringer magnets are of high resistance—usually of about 1000 ohms—and therefore a considerable E. M. F. is necessary to properly actuate them. Moreover, enough E. M. F. must be generated to overcome the resistance of the line, which is distributed between various instruments. A bridged generator should be wound for producing a large current at a comparatively small E. M. F. Its armature, therefore, should be wound to a low resistance with a comparatively large wire, the requisite number of turns being obtained by making the armature core larger.

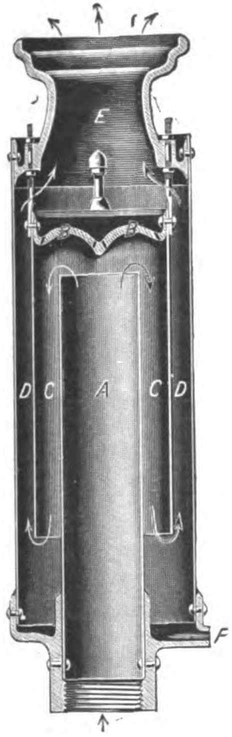
What is the greatest number of bridged bells (1000 ohms) that will work satisfactorily on a grounded line? M. L. C.

A. This depends entirely on the make of the instrument and on the personal equation of the party who must decide what "satisfactory" service means. In general it may be said that it is poor policy to use more than 10 bridging instruments on any sort of a line. It is stated on good authority that as many as 40 instruments have been used on a single grounded line giving fairly good ringing and talking results. The ordinary bridged instrument, however, will not give anything like these results. Ten instruments on a 1000-ohm line is a fair limit. A greater number of instruments, even were the talking and ringing to be perfectly satisfactory, would be very undesirable owing to the confusion arising in interpreting the code of signals which must necessarily be used to enable any subscriber to recognize his own call.

New Apparatus and Appliances

THE BUNDY EXHAUST-PIPE HEAD.

As is well known to all engineers, the functions of an exhaust head is to separate the water and grease from exhaust steam and discharge the former through a drip pipe with proper outlet, the latter being allowed to pass into the atmosphere to be dissipated without precipitation. It is placed as a crown upon the exhaust pipe, and should have as neat and attractive appearance as possible consistent with perfect performance. The makers of the exhaust head illustrated herewith claim that it completely removes the liquids and allows but a light feathery vapor to escape, which readily dissipates without precipitation.



EXHAUST HEAD.

The head is made of heavy iron, thoroughly riveted together, and so designed and constructed as to cause the steam in passing to change its direction three times, doing this, it is claimed, without causing the slightest back pressure on the engine or pump from which the pipe discharges. The three cylindrical shells of which the head is composed, are placed one within the other, and each is of greater area than the one next inside, full capacity thus being given throughout with the element of friction added. There is no crimping of the iron with its incident weakening at the point where the scale is necessarily broken, and as a result the head has long life without any liability of repairs.

Another feature worthy of mention is that the elongated shape greatly reduces the wind pressure, and also gives a maximum exterior condensing surface exposed to the atmosphere an advantage. The Bundy exhaust head described is made by the A. A. Griffing Iron Company, 66 and 68 Centre Street, New York, who will send a book entitled "Sure Cure for Wet Roofs," to those writing who mention this paper.

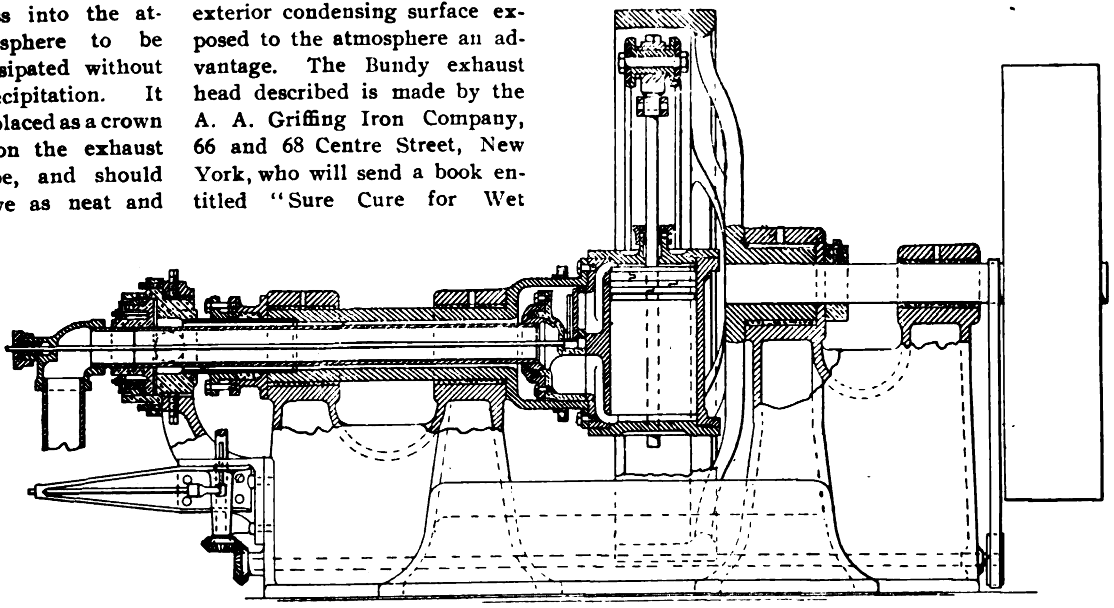


FIG. 2.—LONGITUDINAL SECTION OF RECIPROCATING ROTARY ENGINE.

RECIPROCATING ROTARY STEAM ENGINE.

The engine shown in the accompanying illustration consists of a main wheel or drum mounted to revolve with a horizontal shaft, the drive wheel being on the outer end of the same shaft.

The cylinder is connected to the end of a hollow sleeve and projects into the main drum with its piston rod connected to the inside of the rim of the drum by a yoke frame, all of which revolve together. The center line of the sleeve is parallel to the center line of the shaft of the drum, but below it the distance of one-half the stroke of the piston in the cylinder, as shown in Fig. 2, which represents a horizontal sectional elevation.

The end of the sleeve next the cylinder is enlarged and contains the valve, which is of disk form and is held stationary by a tube which runs back through the sleeve and is secured in a head or bracket rising from the base frame.

The valve is provided with two openings, one through the valve to the steam port face of the cylinder, the other leading into a head and thence into the tube by which the valve is carried. This latter forms the exhaust pipe, while the former constitutes the steam inlet from the sleeve or hollow malleable shaft, to the cylinder. The steam is fed into the sleeve direct from the boiler, entering the cylinder at full boiler pressure.

The steam admission passage through the

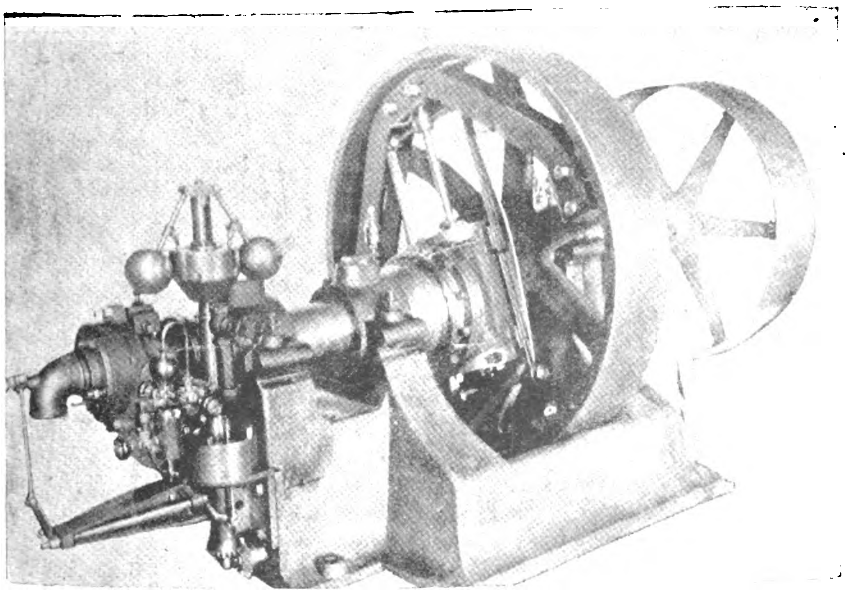


FIG. I.—RECIPROCATING ROTARY ENGINE.

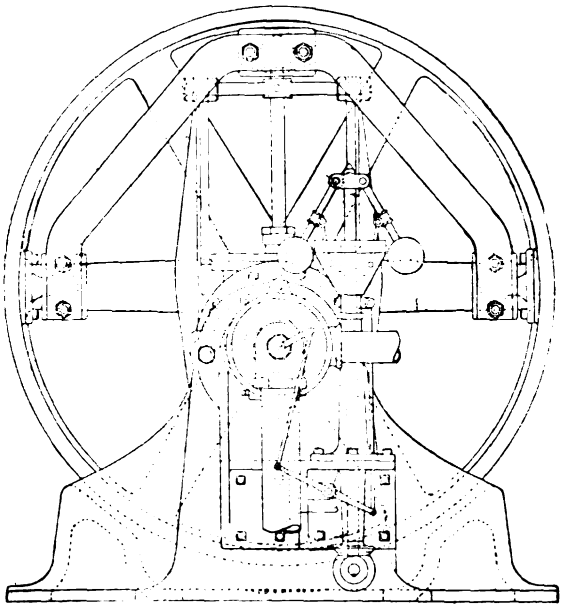


FIG. 3.—TRANSVERSE CROSS SECTION OF ENGINE.

valve is divided into radiating segments which, by means of the automatic arrangement of the governor valve, designate positive points of cutting off the piston stroke in the cylinder.

The governor valve is in the form of a segment and is adapted to be moved over the steam passages by an arm projecting at right angles from a rod running backward through the exhaust pipe, and thence out through a stuffing box, and so arranged as to be rocked by a governor as shown in Fig. 3, which shows an end elevation of engine.

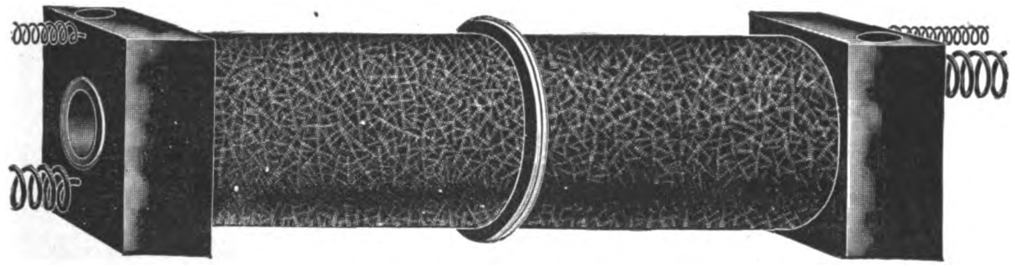


FIG. 1.—VARLEY TELEPHONE INDUCTION COIL, 500 OHMS.

FIG. 4.—VARLEY TELEPHONE MAGNET.

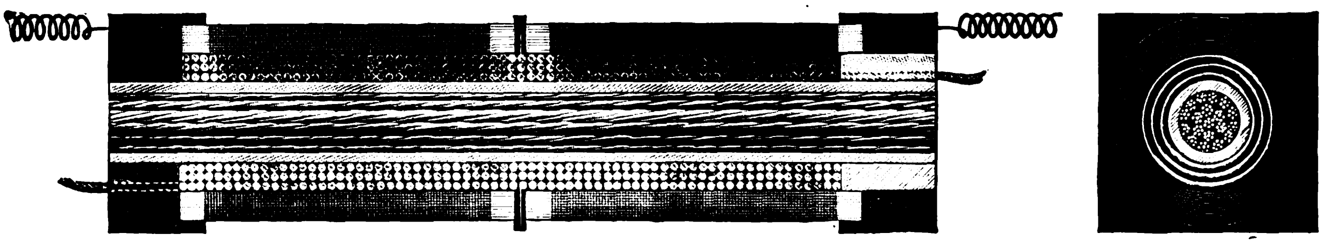


FIG. 2.—SECTIONAL VIEW OF VARLEY TELEPHONE INDUCTION COIL.

When the engine is running slow, and the balls are down, the segmental valve will lie low down on the valve, leaving the steam passage wide open; but when the speed increases, the rising of the balls will elevate the governor valve correspondingly and cut off the steam at an earlier point of the stroke, thus perfectly regulating the speed.

The makers claim that this forms a very compact and economical engine, doing away with many heavy moving parts of the reciprocating engine. The moving parts are all within the fly-wheel or drum, and there is an absence of the jar and friction of the ordinary engine, as all the parts are balanced within the wheel, and the piston stroke is accomplished without the usual back and forward movement.

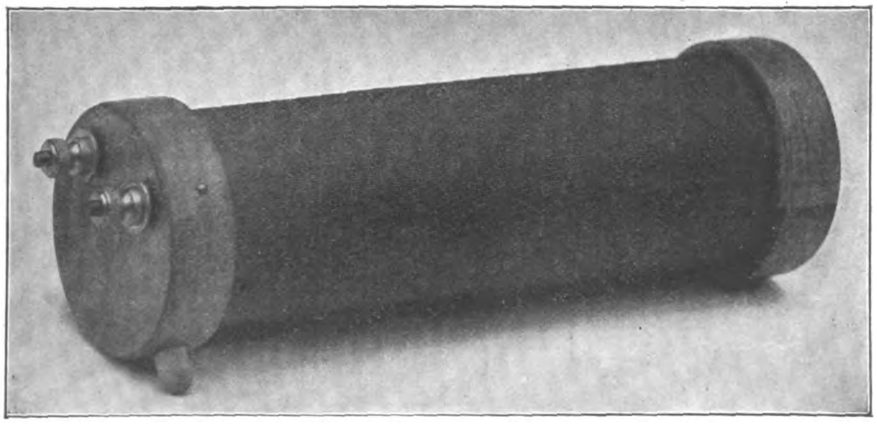


FIG. 3.—VARLEY GAS LIGHTING SPARK COIL.

The valve, called a "boiler pressure expansion balance valve," is claimed to control the steam as accurately as a Corliss valve.

In a recent brake test made by Reichard & Pattee, contracting engineers of Minneapolis, H. C. Kenning, engineer for the Minneapolis Chair Factory, and C. H. Hill, draughtsman for R. R. Howell & Company, the water consumption was found to be 35.46 lbs. per brake horse power, the duration of the test being three hours.

The inventor of the engine described is F. W. Reeves, 1920 Laurel Avenue, Minneapolis, Minn.

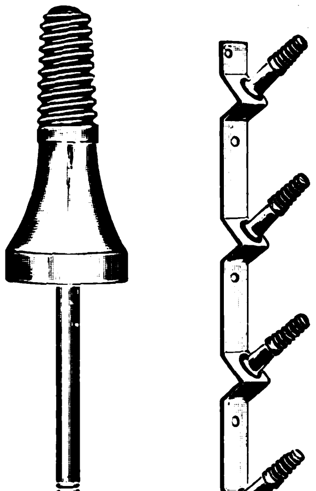
VARLEY ELECTROMAGNETS.

Fig. 1 gives a perspective view of a special Varley coil, Fig. 2 giving sectional views of the same. As will be seen from the latter cut, the coil is built after the manner of a Ruhmkorff coil, and no matter what may be the intensity of the current in the primary it is claimed that there will be no loss by brush discharge inside of the coil, which consequently acts as a highly efficient transformer. Another advantage is that the coil is wound in two halves, each half in an opposite direction, and the terminals of the secondary are consequently brought out from the top layer of each half, two fibre discs separating the two sections. After winding, the coil is thoroughly baked and boiled in paraffine. It is capable of producing with two dry batteries, a ¼ inch spark when used with a condenser which, it is claimed, would be impossible if the coil were wound in one winding for the reason that the actual distance between the top and bottom layer of the secondary would then be only ⅛ inch, which would involve considerable loss when the coil is working at a maximum.

Another new Varley specialty is shown in Fig. 3, being a design of a gas lighting coil containing several late improvements. Fig. 4 shows a telephone magnet having a compact, solid sectional winding. The coil shown has 40 ohms resistance, but the windings are made of any resistance and turns, and is slipped freely on any core. All the above described magnets are made by the Varley Duplex Magnet Company, 138 Seventh street, Jersey City, N. J.

INSULATORS AND INSULATOR PINS.

The triple petticoat insulator shown in the accompanying illustration is a glass insulator for potential up to 20,000 volts, and one very extensively used on high voltage transmission lines. Fig. 1 shows a steel



FIGS. 1 AND 2.—POLE AND BRACKET PINS.

insulator pin with a porcelain base, also used on high voltage power transmission lines. In Fig. 2 is shown a four-pin upright galvanized side bracket for attaching to the sides of buildings to support lines and at the same time to insure good insulation. The above insulator and pins are made by Fred. M. Locke, Victor, N. Y., manufacturer of insulators in glass and porcelain for all electrical purposes.

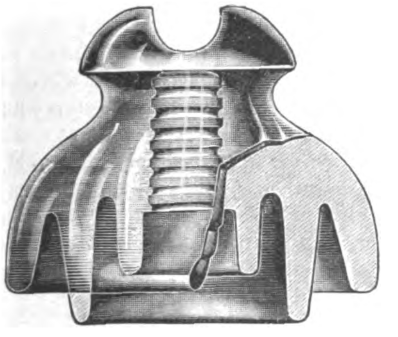


FIG. 3.—GLASS HIGH-VOLTAGE INSULATOR.

INTERIOR THERMOSTATIC ELECTRIC CABLES.

While the usual thermostats, based upon the differential expansion of metals, have their field of usefulness, it is a limited one for several reasons. To afford ideal protection the number of thermostats installed would have to be so large as to make the cost prohibitive in most cases, leaving aside the impossibility of so placing the devices that they would not deface an apartment. In addition, the adjustments are necessarily so delicate that, if the instruments are not regularly inspected, their reliability could not be depended upon.

A new system of automatic fire alarm, which is now being placed upon the market, would seem to obviate entirely the above objections and introduce numerous advantages. This consists in the employment of a cable which is in itself a continuous thermostat. Moreover, the cable, besides its thermostatic properties, also serves as an electrical conductor for an electric bell service, for burglar alarm systems, telephone circuits, etc.

This cable, whose construction is shown in Fig. 1, is made up of an inner copper wire coated with a metal that fuses at the low temperature of 374 degs. F. This inner conductor after being insulated, is wrapped with other conductors and the whole insulated by an outer covering, which may be the usual paraffine cotton insulation, a rubber covering, or any other outside insulation suited to special conditions. Some types of the cable are made with several outer wires, one of which may serve, for example, for bell service, another for fire alarm, another for burglar alarm, etc., the inner conductor acting as a common return.

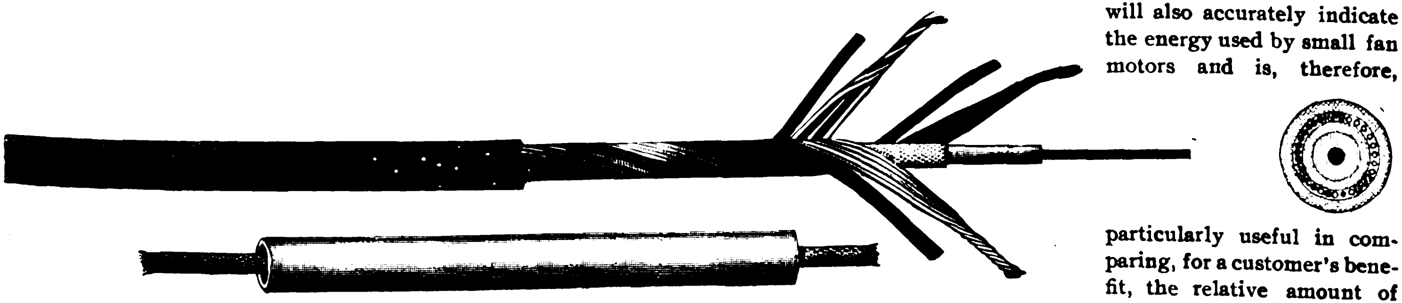


FIG. 1.—THERMOSTATIC ELECTRIC CABLE.

When the cable is exposed to an abnormal temperature, the heat fuses and expands the inner fusible coating and forces it into contact with the overlaying outer wire or wires, thus forming a metallic contact between the inner and outer conductors which completes an electrical circuit and rings an alarm. It should be added that the insulation between the central and enveloping conductors is such that it acts as a flux for the fusible metal, thus insuring, when the critical temperature is reached, an almost instantaneous short circuit.

Though the cable is intended more particularly for protection against fire, it also serves equally well for special protection against burglary, for the reason that if the wire should be cut, connection will thereby be made between the outer and inner conductors and an alarm sounded.

All the details for the use of the above described cables for fire and burglar protection have been worked out in a remarkably thorough manner. In simple house protection, for example, should a cable—whether conjointly employed for bell or burglar alarm service, telephone connections, etc., or for all of these purposes at once—be subjected to undue heat, a loud fire alarm signal will be sounded. Should there, however, be an ordinary short circuit on any of the lines, or, for example, a window raised when the burglar alarm circuit is not disconnected, or when a wire is severed by a sharp instrument, a different signal is sounded. Moreover, by a simple method of connection, the entire system or any part of it can be tested at any point without giving an alarm.

One of the most valuable features of the system is the automatic arrangement for transmitting fire and burglar alarm signals to a distance, the signal being received, for example, in a police station, central fire station or central telephone exchange. This is accomplished by means of mechanism shown in Fig. 2. In the case of fire, a telephone central is automatically called up and the signal delivered through the telephone in the form of distinct beats, indicating the signal number of the building; or a signal in the police or fire station is sounded, giving the signal number of the building. It should be added that the signal for an alarm of fire is entirely different from that for a burglar alarm, so that the attendant in any of the above cases can clearly distinguish between the two. An important point is that in the case of a telephone attachment, there is absolutely no interference with the ordinary telephone service and no special wire is required to be run from the house.

The cable, fire and burglar alarm system just described, has been placed upon the market by the Montauk Multiphased Cable Company, 100 Broadway, New York, which will be pleased to furnish to such of our readers who apply, further particulars concerning the same.

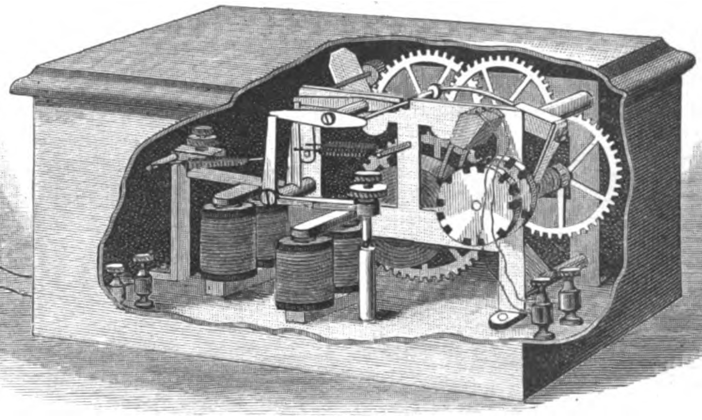


FIG. 2.—FIRE AND BURGLAR ALARM AUTOMATIC TRANSMITTER.

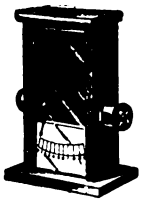
LAMP INSPECTOR'S WATTMETER.

A portable instrument to determine accurately and rapidly the watts required by a lamp is of great value in selecting new lamps and in testing lamps in service, and for this purpose the General Electric Company has recently designed and introduced the Thomson portable indicating wattmeter.

The indicating wattmeter will also be found valuable in testing lamps in barrel lots, either with or without a photometer. It will also accurately indicate the energy used by small fan motors and is, therefore, particularly useful in comparing, for a customer's benefit, the relative amount of energy required by a fan motor and an ordinary incandescent lamp. By supplying the secondary of a transformer with current, its core loss may be easily determined by the indicating wattmeter. The capacity of the instrument, which can be used with both direct and alternating current, is 150 watts.

INEXPENSIVE AMMETERS AND VOLTMETERS.

A type of inexpensive testing instrument for both students and practical electricians is illustrated herewith, made as a voltmeter reading from 0 to 10 volts, or an ammeter reading from 0 to 10 amperes. They are not toys because sold at a low price, but are well constructed practical instruments, and intended particularly for amateurs and others experimenting with batteries, dynamos, motors, or using current for any purpose, to whom the standard instruments are too expensive. These instruments are made by the Cherry Electric Works, 25 Third Avenue, New York.


A CHEAP AMMETER.

ELECTROSTATIC GROUND DETECTOR.

The General Electric Company announces a new ground detector to take the place of the transformer and lamp method, which, although hitherto extensively used, has never given more than a rough indication of the condition of the lines. In the transformer and lamp method of ground detection, the extent of the ground is indicated by a lamp in the secondary circuit of the transformer, but on account of the capacity of the lines, the lamp nearly always glows, and the actual condition of the line is difficult to ascertain.

2000
0
2000
ELECTRO-STATIC
GROUND DETECTOR
No
PATENTS APPLIED FOR
GENERAL ELECTRIC CO.
SCHENECTADY
NEW YORK
U.S.A.
ELECTROSTATIC GROUND DETECTOR.

The new device here illustrated is a switchboard instrument, and is similar in construction to that of electrostatic voltmeters used in laboratory work. Briefly, it consists of four rigidly fixed sheet metal quadrants, between which is space for the accommodation of a vane carrying an indicating needle. The two lower quadrants are connected internally to the lower binding post for connection to the ground, and the two upper to the right and left binding posts, respectively, for connection to the lines. The vane with its needle is pivoted at the centre of the circle formed by the four quadrants, and is slightly counter-weighted to balance the weight of the needle.

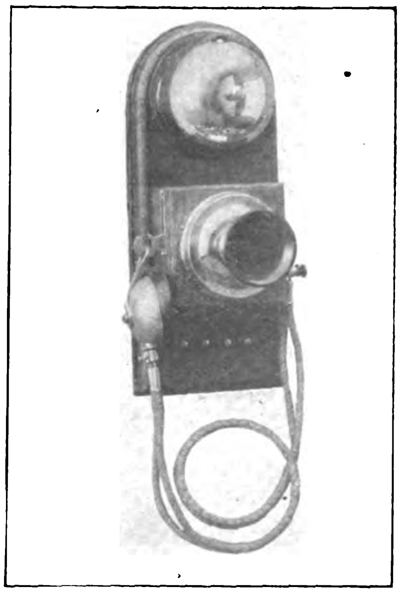
In common with all electrostatic instruments the operation of this ground detector depends on the tendency of the vane to place itself in the position giving the greatest condenser capacity. If no ground exists on the line, the vane lies across the shortest path between the positive and negative quadrants—the right and left upper quadrants—and the needle points to zero. If, however, either side of the system be grounded, the two lower quadrants cease to be neutral, the system is out of balance, and the vane, taking a new position, deflects the needle to the right or left, indicating the grounded side. A special feature of the construction is that the moving mechanism is insulated and has no electrical connection with either side or with the ground. If it were connected to either side of the line or to the ground, a burn-out might possibly result, but being insulated, the moving mechanism can come into contact with one of the quadrants without causing any damage. It may be used for temporary connection to any desired line, or one for each feeder may be permanently installed.

This electrostatic ground detector is constructed for 1000, 2000, 5000 and 10,000 volts, and is set in a black japanned case with cover finished in polished nickel.

INTERCOMMUNICATING WALL TELEPHONE SET.

For rapid communication between offices and floors in a building, a number of telephones advantageously placed and so connected that any one telephone station may call and converse with any other station, is coming to be recognized as a necessity.

An objection met heretofore in carrying out such an installation has been with respect to the complicated switch-board devices. In the telephone set illustrated, all switches, plugs, individual batteries, etc., have been eliminated, and to call the station required, it is merely necessary to remove the receiver and press on the proper signalling key.


INTERCOMMUNICATING TELEPHONE SET.

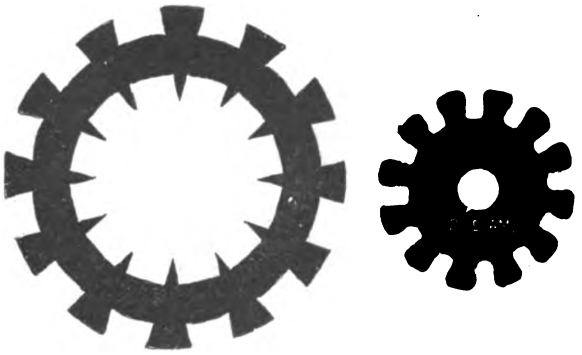
The telephones are provided with long-distance granular carbon transmitters and standard watch case receivers. They are easily set up and connected, and being substantially constructed and simple in operation, do not require re-adjustment or repairs.

Four ordinary carbon batteries, located at some convenient point, are sufficient for a four to eight station system, and will operate continuously from one to three years without recharging.

The system described has been brought to its present perfection principally from the designs and efforts of Mr. A. R. Hussey, chief electrician of the Allen-Hussey Company, 211 Randolph Street, Chicago.

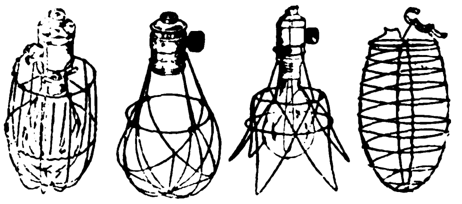
SMALL ARMATURE PUNCHINGS.

In making small motors, if a punching press is not available, one of the most tedious operations is cutting out the armature discs. The type of punching illustrated herewith is made by the Mianus Electric Company, Mianus, Conn., for the convenience of amateurs and others who wish to make a small or special type of machine. The punchings are 2 in., 3 in. and 3½ in. in diameter, and are of a special quality of soft iron.


SMALL ARMATURE PUNCHINGS.

WIRE LAMP GUARDS.

The accompanying illustrations show several different patterns of wire lamp guards, having the holder part of the guard, thus obviating the nuisance and expense involved with forms of guards which have to be fitted with holders. The guards are all made of tinned wire, the gage being such that sufficient strength is obtained with a minimum interference with the light. One of the forms, it will be noted, is a standing guard for desk or other use, and which also makes a frame for silk or paper shades. The guards illustrated are made by P. R. Wagor & Co., Springfield, Mass.


WIRE LAMP GUARDS.

TRADE PUBLICATIONS.

Dynamo Brushes. Chas. Wirt, 1028 Filbert Street, Philadelphia, has issued a new catalogue devoted to Wirt dynamo brushes and rheostats, and the Queen-Wirt commercial measuring instruments. Reprints are included of many flattering testimonials to the merit of Wirt brushes.

Correction. The General Electric Company desires to advise all holders of their complete Incandescent Lamp Catalogue, noticed in January issue, of an error in the appendix, in the table on page 58. The figures .662 in the column "Life Factors" should be .562. They request that all holders of the catalogue make this correction.

Motors and Generators. The Elwell-Parker Electric Company, of America, is to be congratulated on the excellent appearance of its new catalogue, and particularly on the execution of the accompanying half-tone engravings, which latter are of a quality rarely equalled. Various types of apparatus are shown, both separately and as parts of installations.

BUSINESS NEWS.

De Veau & Company have removed their office and factory from 32 Frankfort Street, to 27 Rose Street, New York City.

The General Electric Company is building thirty six additional 175-HP. motors for the Metropolitan West Side Electric Elevated Road.

Mr. Fred. L. Cross, until recently electrical engineer and manager of the electrical department of the Buffalo Engine Works, has opened an office as electrical engineer in the Mooney & Brisbane Building, Buffalo N. Y.

The Montreal Electric Company having outgrown their present long established quarters at 302 St. James Street, Montreal, will shortly remove to a more spacious place of business at 1819 Notre Dame Street, in the Balmoral Hotel Block.

Change of Firm Name. On January 1, the Partrick & Carter Company, 125 South Second Street, Philadelphia, changed its name to Partrick, Carter & Wilkins, the firm consisting, as formerly, of Messrs. Franklin S. Carter, Charles M. Wilkins and E Ward Wilkins.

The Safety Insulated Wire Company has closed a contract through Mr. E. J. Spencer, its Western agent, for all the conductors, inside wire, cable and underground cable, for lighting and power at the Trans-Mississippi & International Exposition, to be held at Omaha. Mr. Spencer has removed his office in St. Louis to the Laclede building.

Special Electrical Apparatus The Reading Electrical Manufacturing Company, Reading, Pa., does a jobbing business in supplies, and make small motors, dynamos and portable instruments for electricians and amateurs. The company is always glad to enter into correspondence concerning the construction of special apparatus, which it is equipped to build at prices within every one's purse.

The Electric Appliance Company, Chicago, reports that its new issue of General Catalogue No. 12 is now very generally distributed all over the country and is producing very satisfactory results. Certainly very few buyers could resist the temptation of ordering from such a handsome and useful publication. Such of our readers who have not yet obtained a copy may do so by sending their business card to the Electric Appliance Company.

Incandescent Lamps. The lamp department of the K. & W. Company, Pittsfield, Mass., is now in full operation. Many duplicate orders are now being received from sample orders placed in December. Only the most highly skilled workmen obtainable are employed by the K. & W. Company, which assures technical accuracy and mechanical finish. The company finds the outlook for future business very flattering.

H. B. Coho & Company, of St. Paul Building, New York, commence the new year with a most satisfactory budget of contracts. Among these may be mentioned a plant for the Lane Shoe Factory, consisting of 80-KW. dynamo and four motors; a 75-KW. alternator for Lancaster, Pa.; a complete plant for a Dye Works, at Lodi, N. J.; a complete plant for Frestburg, N. Y., and a water power plant for Long Island.

The Anchor Electric Company has recently had several changes in its personnel, Mr. H. C. Hawks and Mr. Phillip M. Reynolds having retired after selling their interests to Mr. Norman Marshall, Mr. George O. Proctor, Mr. Guy H. Proctor and Mr. Frank Ridlon. Mr. Geo. O. Proctor will hereafter be president, and Mr. Norman Marshall, treasurer. Mr. Proctor is equally well known in public and business life, having been a prominent member of the Massachusetts legislature.

Circuit Breakers v. Fuses. While the discussion rages over the question of whether circuit breakers are going to be used or not, the concerns making the favorite types of circuit breakers are working night and day, and with difficulty only are able to keep up with their orders. The Ward Leonard Company say they have all they can attend to in this line, and yet expect a still further increase in the demands upon their manufacturing facilities for circuit breakers.

The Central Telephone and Electric Company, of St. Louis, which recently succeeded the D. A. Kusel Telephone Manufacturing Company, has just purchased the stock of goods carried by the Missouri Telephone Manufacturing Company, and taken over the business of that firm. This enterprising firm has already become one of the principal forces in the telephone field, its energetic business methods and evident desire to furnish only the most reliable and highest grade goods being appreciated by the public.

Exposition Awards. Three diplomas of merit to one concern shows pretty well what the judges of the Tennessee Centennial Exposition (held at Nashville in November) think of the Robertson-Thompson indicator, Lippincott planimeter and Eureka packing. Jas. L. Robertson & Sons, New York, entered these three articles, and inform us they were awarded these prizes. They say that if engineers and steam users send for illustrations and descriptions of these goods, it will be both to their interest and profit.

Geo. W. Patterson has recently been appointed western representative in charge of the well known office of the American Circular Loom Company, at 1114 Marquette Building, Chicago. Mr. Patterson is well known to the trade through his connections as Western agent for the Gordon Burnham and Law primary and Ohio storage batteries, and Medbery Knife switches and Overhead Railway Material, which companies he will still represent. Mr. Patterson reports business good for the season with a bright prospect for the future.

A Gratifying Engine Business. The Fitchburg Steam Engine Company, Fitchburg, Mass., is receiving a very good share of the new work now being done in their line. Among the recent orders booked by this company are for a 600-H P cross compound engine with rolling mill beds for the Fitchburg & Leominster Street Railway Company; a 350-H P tandem compound condensing engine for a silk mill at Easton, Pa.; a 250-H P engine for a brick plant at Woodbridge, N. J.; a 125-H P engine for a cotton mill at Adams, Mass.; a 120-H P engine for a chair factory at Gardner, Mass., and a 120-H P engine for a paper mill at Newark, Del., beside several others.

The Thresher Electric Company, Dayton, O., for some time has been working a double shift of men in order to catch up with its orders and the constantly increasing business will soon demand a considerable extension of manufacturing facilities. The design of the generators and motors manufactured by this enterprising concern is such as to particularly adapt them for power work of all descriptions, which accounts for the many installations of Thresher machinery made for general and special power distribution in manufactories. Among the recent installations is one in a large printing house in New York City, of which we hope to print a detailed description in an early issue.

The Burnham-Hall-Chase Company 146 Franklin Street, Boston, Mass., is a newly incorporated company composed of several energetic young men well known to the electrical trade. Mr. F. A. Hall, president, has been associated with the engineering department of the General Electric Company for the past six years and is well known to the electrical fraternity. Mr. W. W. Burnham, treasurer and general manager, hardly needs an introduction, as through his connection with the Electric Gas Lighting Company and other electrical enterprises, he is well and favorably known throughout the trade. The new company will handle a line of electrical specialties, and do an electrical engineering business; it will make a specialty of primary batteries and also of storage battery installations.

Lamp Guards. P. R. Wagor & Company, Springfield, Mass., call the attention of supply dealers to the fact that they have the exclusive right to manufacture the "Acme" lamp guard, having in 1895 purchased of the patentee all rights under letters Patent No. 502,458, dated Aug. 1, 1893. Irresponsible manufacturers of Boston and Detroit, they state, are placing on the market similar guards of inferior make, and as all dealers handling such guards are liable as infringers their attention is called to the rights held under letters patent. The manufacturers of the "Acme" guard have received within a few days from the largest electrical supply house in the United States, a letter in which appears the following voluntary testimony to the superiority of these guards over all others. "We must admit that the guards made by you are superior to any in the market."

The Sprague Electric Company, of New York, has secured the contract for motors to be installed in the new works of the John Stephenson Company, Ltd., Elizabethport, N. J. This is a large and important contract and some forty-eight motors will be utilized, ranging from 3 HP to 40 HP, mostly large size machines. The motors will be of the well known Lundell type, and will be direct connected, belted or coupled to the latest types of wood working machinery. As is generally known, the Lundell motors are of the inclosed type and are admirably adapted for use in wood working machinery establishments where, of necessity, the atmosphere is filled with dust. Several large size Lundell direct-connected exhaust fan outfits will also be included in the equipment. The plant will be one of the largest of its kind in this country and will be equipped exclusively with the Lundell motors.

The Weston Electric Istrument Company, it is reported, is considering the construction of a large manufacturing plant near the Waverly, N. J., station on the Pennsylvania railroad. In an interview with a newspaper reporter, Mr. Edward Weston stated that the time when the work of erecting the buildings will be started will depend largely on the condition of his health. When completed a large number of men will be employed. There will be several factory buildings for the manufacture of electrical instruments and machinery, and a number of new inventions in the electrical line be produced. For the new machinery a line of special tools will be designed. According to the newspaper report, two companies have been organized and a third has nearly completed its organization; while nominally separate companies they will be a unit in making the undertaking a success.

American Institute Medals. The American Institute Fair, held at Madison Square Garden, New York City, last fall, has just delivered exhibitors' medals awarded them on their goods. The A. A. Griffing Iron Company, 66 and 68 Centre Street, New York, received medals on the following goods: Bundy heaters and radiators, steam traps, gravity pumps, feed water heaters, steam and oil separators, exhaust heads and low water alarms. Those who were fortunate enough to view the exhibit of the A. A. Griffing Iron Company were loud in their praise of the tasty manner in which the exhibit appeared. Occupying a prominent space in the exhibit was the Bundy gravity pump in actual operation, taking water from one tank, carrying 5 lbs pressure and putting it into another tank, carrying 100 lbs. pressure, after elevating the water through pipes for about 100 ft. towards the roof of the Madison Square Garden. There was also in actual operation the Bundy separator, which received high tribute at the hands of the judges.

Telephone Coils and Electromagnets. The Varley Duplex Magnet Company, 138 Seventh Street, Jersey City, believe that telephone manufacturing companies have enough troubles of their own in properly making special details of their apparatus, and therefore have little time to devote to the subject of induction coils, especially since such coils have to comply with many different specifications, such as for lines of variable resistances, variable electrostatic capacities, low insulation resistances, leaky paper cables, etc.; consequently this company has made a special study of induction coils, which they manufacture in forms best adapted to the various transmitters on the market and to comply with the various other conditions arising that are apt to baffle manufacturers. It has also, at considerable expense, perfected automatic machines for accurately winding induction coils and, in fact, all kinds of telephonic magnets, the machines producing not only absolutely reliable work but at an extremely low price. Telephone manufacturers will undoubtedly find it to their advantage to look up the matter of Varley magnets.

A Large European Order. The General Electric Company has received orders from The British Thomson-Houston Company, Limited, covering the complete locomotives for the Central London Underground Railway. The original contract between the two latter companies included, with the special gearless motors and other electrical equipment, thirty-two locomotives for this important underground system, but these it was supposed, would have been built in England. The decision to confide the construction of the locomotive cabs and trucks as well as the electrical equipment, to an American firm is, therefore, a very gratifying testimonial to American manufactures. The locomotives will each weigh about 45 tons, and will be equipped with a total of 800-HP. in motors. The trains to be hauled will be made up of five cars, giving a total load of 150 tons, 10 tons heaver than the ordinary Manhattan elevated trains. The schedule speed will be 15 miles an hour. The diameter of the tunnel being 11 ft. 6 ins. only, motor cars could not be used. The entire electrical equipment will, therefore, be placed on locomotives which will probably resemble in appearance those in use on the Manufacturers' Railroad in New Haven, Conn., and on the Hoboken Shore Road, Hoboken, N. J.

Recent Walker Contracts. The Walker Company is now building at its Cleveland works a 1600-KW direct-connected generator for the Union Railway Company of New York City. This, with the two now being completed for the Brooklyn Heights Railroad Company, will make three of these 1600-KW machines, finished in as many months. In addition to this generator the Walker Company is building for the Union Railway Company forty double No. 4 A street railway equipments. The equipments are to be fitted with the new type "S" solenoid blow-out controller, which has attracted so much attention. The current for these motors will be fed to the line from a Walker switch-board, now being built at New Haven. The Metropolitan Street Railway of Kansas City, which is now operated by a 1600-KW Walker generator, is about to increase its plant by the addition of a generator of 1200 KW capacity, and as a contrast to these immense machines it may be mentioned that the company is building a 25-KW lighting generator for Mr. J. J. Astor's new yacht. The foreign shipments during the next few months will include one hundred double 3 S street railway equipments, with 200 controllers, for Dresden, Germany; six double No. 3 N equipments with Type "S" controllers, and two double No. 3 N equipments. Besides these railway motors and accessories there will be one 150-KW belted railway generator with its switch-board, and a 75-KW belted booster for Japan, also with a switch-board. This makes over 7500 HP in street railway motors alone that are being built at the Cleveland works, to say nothing of the HP output in generators.

A Farewell Banquet. It having been decided to remove the auditing department of Westinghouse, Church, Kerr & Company from their New York to their Pittsburg office, it became necessary for Mr. Warren L. Murray, the auditor, and Mr. Gardner W. Kimball, his associate, to remove their residences permanently to the smoky city. Mr. Murray has been connected with the company for fifteen years, and Mr. Kimball nearly as long, and during this long service have so won the respect and love of their associates that the latter determined to give them a send-off in the shape of a farewell dinner. This took place in the large private dining room of Mouquin's Fulton Street Restaurant on the evening of Jan. 5, and was taken advantage of by all of the engineering force of the company who were within reaching distance of New York, there being twenty-two plates. During the dinner, Mr. W. C. Kerr referred in terms of high appreciation to the departing guests, and remarked that this was the first occasion on which the force had been gathered together in this way, and suggested that an annual, or even more frequent, dinner might be an excellent idea. After Mr. Kerr, the regular toasts were called by Mr. O. L. Williams, treasurer of the company, and these continued for the remainder of the evening, every one present being called upon to respond. Late in the evening presentations in token of the high regard in which Messrs. Murray and Kimball were held were made in the names of the members of the force, and thus ended one of the pleasantest affairs in the history of Westinghouse, Church, Kerr & Company.

MILWAUKEE CONVENTION NOTES.

F. H. Clark took good care of the interests of the Electric Storage Battery Company.

J. Gilbert Hickox and **F. W. Bacon** did the honors for the American Rheostat Company.

The Sawyer-Man Electric Company was represented by Mr. Clarence A. Ross, of Chicago.

Manager Donohoe and Western Agent Hammond represented the American Electrical Works.

Sargent & Lundy, engineers and contractors of Chicago, were represented by Mr. T. E. D. Retchie.

John Child took care of the interests of A. O. Schoonmaker, and explained the merits of India mica.

Mr. A. C. Foster, of Foster & Louis, Chicago, represented the Triumph Electric Company, Chicago.

The Perkins Electric Switch Manufacturing Company, was represented by Mr. Edward J. Patton.

The Safety Insulated Wire & Cable Company was represented at the convention, by Mr. M. B. Austin, of Chicago.

A. B. Conover, Jr., looked out in an efficient manner for the interests of the J. A. Roebling's Son Company

Filer & Stowell Company, Milwaukee, was on hand with several representatives who also acted as hosts to the out-of town visitors.

Mr. Edward R. Grier, Western manager of the Byrant Electric Company, did the honors for his firm in the most approved fashion.

Mr. Jacob Cloos, of the Cloos Electrical & Engineering Company, was one of the busiest men at the convention and was very much in demand.

Mr. E. W. Buss, Western representative of the Chapman Valve Manufacturing Company, was a "heavy-pressure" representative for his concern.

Geo. Cutter, of Chicago, renewed his many acquaintances at the convention, and incidentally had a good word to say about Cutter's line of supplies.

The Varley Duplex Magnet Company, Jersey City, was kept in evidence by J. Mason Knox, who showed a line of samples of Varley magnets and coils.

The Yaryan System of heating residences, stores and public buildings from a central station, had an able representative in the person for A. J. Stahl, of Laporte, Ind.

Mr. F.S. Hunting, Mr. Thomas Duncan and **Mr. A. L. Draffen** kept the delegates well informed regarding the merits of the Ft. Wayne Electric Corporation's apparatus.

Mr. James F. Cummmings, president of the Armorite Interior Conduit Company, Pittsburgh, attended the convention; although a late arrival, he soon made up for lost time.

Mr. Chas. G. Guild, secretary and treasurer of the Jenney Electric Light & Power Company, Ft. Wayne, Ind., made his presence felt among the delegates in his usual courteous manner.

Mr. G. A. Hurd, of the Crane Company, Chicago, was very much in evidence and made many friends for his company. Mr. Hurd carried the Crane Company's exhibit on his watch chain.

The Northern Electric Manufacturing Company, of Madison, Wis., was one of the prominent factors in the success of the commercial side of the convention, making a fine display of exhibits.

The Northern Electric Company, of Madison, Wis., was represented in the person of President Fox, who kept the good features of the Northern motors prominently before the delegates.

The Crocker-Wheeler Electric Company was represented by Mr. Julian Roe. Mr. Roe did some active hustling and reports the business of the C. W. Company in a very prosperous condition.

Mr. James Wolff, Chicago manager of the New York Insulated Wire Company, was able to spend but a few hours at the convention; these few hours, however, were very much appreciated by "Jim's" friends.

The Siemens & Halske Company, in Mr. McGill had a representative who was much in demand, particularly to answer enquiries concerning 220-volt plants, which were so often referred to in the papers read.

Everybody was glad to see "Commodore" Col. Copeland, of the "Upper Mississippi River Squadron." This genial gentleman will be long remembered for his unbounded hospitality at La Crosse last summer.

There may be others but L. W. Burch, of the Electrical Supply Company, of Madison, was one of the most popular attendants at the convention. Mr. Burch has the honor of being the oldest electrical traveling salesman in the northwest.

McGill & Pomeroy, of Chicago, who sell railway supplies, porcelain, water motors, etc., arrived at the convention in detachments—that is, Pomeroy got there first and McGill came after. As one delegate expressed it, this couple make a "warm team."

Mr. W. M. Smith, of the Chicago Insulated Wire Company, spent Thursday at the convention. Mr. Smith reports the demand for insulated wire very satisfactory, and says he has every reason to believe the coming season will be one of the best in their history.

Prof. Dugald C. Jackson, of the University of Wisconsin, took in the convention. He states that the University has its full quota of electrical and engineering students, the University having at present about all that can be conveniently handled with satisfaction.

Mr. Thomas R. Mercein, in his usually pleasant manner, added to his list of friends many who before knew him only by reputation. He endeavored to assist every one in having a good time, and he succeeded in making the convention a meeting long to be remembered.

Mr. H. J. Gille, the St. Paul representative for Washburne & Moen Company, has a "wire" on a host of friends aside from the large number who purchase his trade wire. Mr. Gille is one of the enterprising, up-to-date men of the Northwest, and has the best wishes of a host of friends.

The Cloos Electrical Engineering Company, Milwaukee, exhibited a primary switch for a two-phase alternating system; also a line of alternating direct-current junction boxes, a single wire direct coupling box, a double wire alternating coupling box, and a house lamp-post direct series switch.

Mr. John S. Maurer, of the Crouse-Tremaine Carbon Company, Fostoria, O., had a kind word and a hearty hand-clasp for all of his many friends. The Fostoria Incandescent Lamp Company, Fostoria, O., are to be congratulated on having such an enthusiastic and capable representative as Mr. B. M. Myers proved himself to be.

Rohn & Meyer, Milwaukee, had on exhibition a line of Helios incandescent arc lamps, consisting of 5 and 3 ampere, 220-volt, single alternating 100-volt. These lamps are claimed to be the longest burning arc lamps on the market, and direct current lamps burning 175 to 200 hours and alternating lamps burning 100 hours.

Association Recruits. To no one is more credit due for their able efforts in keeping a watchful eye upon the membership rolls of the convention than Mr. Thomas R. Mercein, Mr. Joseph M. Hill and Mr. W. W. Low. Nearly 50 new members were brought into the convention through the efforts and recommendations of these gentleman.

Mr. W. L. Church, general manager of the lighting department of the Milwaukee Lighting & Railway Company, spared no effort in furthering the pleasure and entertainment of the delegates. Mr. Church had charge of the local theatre party, and through his efforts many acqaintances were made and many pleasant hours passed.

Mr. G. F. Whitfield, of Milwaukee, attended the convention. Mr. Whitfield has just received the appointment as state representative for the Columbia Incandescent Lamp Company, St. Louis. This gentleman also represents Pass & Seymour, of Syracuse; Queen & Company, Philadelphia, and the Simplex Electric Company, of Chicago.

"Uncle" Geo. Searing and "Papa" Ned Grier, the two great switch men of the Northwest; the former representing Hart & Hageman, of Hartford

Conn., and the latter of the Bryant Electric company, of Bridgeport, Conn., occupied Room 118, Hotel Pfister. This is another great illustration of the "Lion and the Lamb lying down together."

The Electrical Engineering Company, of Minneapolis, had its interests well looked after by President F. Morgan Brooks, aided by C. R. Gilman. Mr. Brooks reports the business of the Electrical Engineering Company as being in a very prosperous condition, and he was much elated over the splendid prospects in evidence for his company for the coming season.

George W. Patterson was present as representative of the Medbury railway supplies, American Circular Loom conduit, Gordon-Burnham and Law primary batteries and the Ohio storage battery. That Mr. Patterson made good use of his time in Milwaukee was evident from a large order that he secured from the Milwaukee police department for Gordon-Burnham batteries.

Mr. Chas. E. Gregory, of the Elliptical Carbon Company, of Chicago and Cleveland, attended the convention in all his pristine glory. Mr. Gregory did not attempt any elaborate exhibit, but the search light which he had mounted at the distant end of one of the corridors, beamed upon the convention in as brilliant and kindly a manner as did Mr. Gregory himself.

Genial Tom Ferris, Wisconsin representative for the General Electric Company, proved a host in himself. Everybody who knows Tom Ferris, knows something good about him, and it would be a disappointment indeed not to meet Mr. Ferris at the Northwestern convention. Mr. Ferris has, by his sterling ability and energy, acquired an enviable reputation as a salesman.

The Central Electric Company was represented by Mr. Chas. E. Brown, secretary, and by Mr. W. P. Upham. The exhibit consisted of an Edison Home Phonograph, an instrument especially designed for entertaining evening parties. This phonograph is remarkable for its distinct enunciation—in this respect it is unsurpassed. Room 6 was a centre of attraction, and the songs received many encores.

They say that "Tom" Grier "came up" to the convention on a boat. Mr. Grier arrived in a very spirituelle and generally "pale and interesting" condition. "Tom" says the night on the boat was worse than "a long and short man" hold-up in Chicago, because, when they hold up a man in Chicago all that he is required to do is to throw up his hands; this, however, did not seem to be the limit on the boat.

The Electrical Supply Company, of Madison, for the first time in the history of the convention did not make an exhibit. This is due to lack of time on account of the large amount of business this firm has been doing lately. However, they interested the members of the convention by distributing their new illustrated catalogue, which undoubtedly proved as attractive as an exhibit. Messrs. Burch & Stagg did the honors.

The McDermid Manufacturing Company was represented by Mr. C. L. Burlingham. Mr. Burlingham carried two tin boxes in his pocket; one box contained two sponges and a chamois skin; the other had some of his famous "cleanor." Mr. Burlingham demonstrated to the satisfaction of many of the central station delegates the fact that "cleanor" was a "good thing" for wood-work in cars, brass-work, etc. "Cleanor" is certainly a good article and was well represented by an able advocate.

"Billy" Lowe did not wait for anybody's old wagon to carry him, but waded right into the convention, after the genuine good time so characteristic with this gentleman. Mr. Lowe had a host of friends at Milwaukee who listened with interest and pleasure to his descriptions of the various good goods the Electric Appliance Company always has in stock. Unfortunately, Mr. Stacey, of the Electric Appliance Company, could not attend the convention, having been detained by the pressure of business.

The American Rheostat Company's exhibit consists of a ½-HP, 110-volt automatic starter, a 5-HP, 110-volt automatic starter, a 7½-HP, 110-volt automatic starter, and the front of a 100-HP, 110-volt automatic starter. Also a 5-HP, 220-volt automatic speed controller, a 40-KW, 110-volt rear of switchboard field rheostat, a 3-KW, 115-volt wall type field rheostat, a 10-HP, 220-volt reversible elevator controller, a 5-HP, 220-volt "Perfection" starter, a front for a 20-HP, 220-volt "Perfection" starter, and a controller for sewing machine work.

The Columbian Incandescent Lamp Company, St. Louis, Mo., had a full line of lamps, showing the regular lamps of their manufacture. An interestinfi feature was the exhibit of the materials showing the different stages of filament making; the liquid in its first stage, the threads before carbonization, the carbonized and treated filaments, etc. They also showed some of the original Goebel lamps, which attracted much attention. Mr. A. C. Garrison, secretary and treasurer; Mr. Geo. P. Rex, Chicago manager, and John E. Randall, factory superintendent, were present.

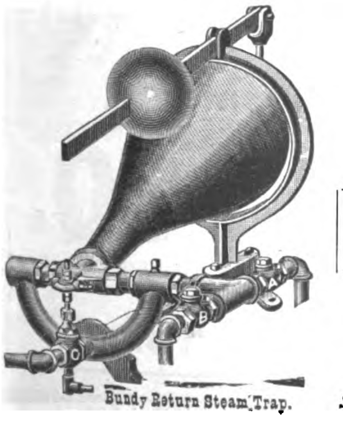
The Phœnix Glass Company, New York, Pittsburgh and Chicago, was represented by Western agent E. H. Fox, assisted by Chas. C. Frick. This company showed a full line of silver etched and cut-glass electric globes and shades of the most up-to-date patterns and styles of prevailing interior decorations. The "Glad hand" in the shape of a large opal glass hand was one of the most interesting features of the exhibit. This exhibit attracted considerable attention, especially as regarded the arrangement of the display, and many favorable comments were heard from the delegates over the representation tendered by the courteous gentlemen in R. 22.

The People's Electric Company, of Madison Wis. was ably represented by Mr. F. H. Ford and Mr. C. W. Bacon, who exhibited a Northern motor, which evoked considerable interest, and was especially admired because of its exquisite and handsome finish; this particular motor having been designed for the University of Wisconsin. They also had on exhibition the New Ritter "Time Saving Soldering Iron," an iron that is always hot, ready and reliable; Fagan combination cut-out and switch, and a regular line of electrical supplies comprised the balance of their exhibit. This exhibit was, perhaps, to central station delegates, about the most popular shown, and Messrs. Ford & Bacon are to be congratulated on the fine showing they made.

The General Electric Company, was represented by Messrs. F. N. Boyer, J. Scribner, R. A. Swain, from the Chicago office, and Thomas Ferris, of Milwaukee. The display of this company attracted much attention, and comprised all the latest types of electric lighting appliances and instruments. Among these were a direct current magnetic blow-out lightning arrester for use on circuits up to 850 volts, and also the Niagara type of Wirt lightning arrester. Several different types of arc lights were shown and also a new series arc cut-out and ceiling board. The new lamp inspectors' indicating wattmeter attracted marked attention, as well as the new electrostatic ground detector, and also a pocket case containing a complete set of repairing and adjusting tools for Thomson's recording wattmeter. Another feature that attracted attention was the display of the small direct-current motors ranging from ⅛ to 1 HP.

Mr. James C. Wormley exhibited a line of Wormley & Shelby lamps ranging from 200 to 250 volts and from ⅛ to 50 CP consisting of about 75 regular and 100 miniature lamps, no two of which were alike. Filaments were also shown in various stages of manufacture, and especial attention was called to the square cut filaments manufactured exclusively in this country by Professor A. A. Shaillet, technical manager of the Shelby Electric Company, and squirted cellulose filaments made by Jos. Hardwick, superintendent of the above company. The filaments were shown in a liquid form, before and after drying, carbonized, also mounted and treated The finished lamps were shown burning on a frame made expressly for the convention. The 3-watt, 220-volt lamps attracted a great deal of attention, as they were the first lamps ever shown in that efficiency of 220 volts.

The Dearborn Drug & Chemical Company, of Chicago, were most generous with souvenirs. They presented to the delegates a handsome silver-plated match-box, on the reverse of which was a very appropriate ad.; they also gave out a neat, serviceable paper-covered lead pencil; on each slip of the lead pencil cover being printed a separate and distinct advertisement of the Dearborn Company, so that every time the user sharpens his pencil, the merits of the Dearborn compounds will be kept prominently in mind. In addition to this, this company also presented a fancy letter opener and a neat blotting pad. Mr. W. H. Edgar was present and assisted by Mr. C. S. Kehler, the Milwaukee representative, made many friends among the central station men present. Mr. Edgar states that the sale of Dearborn compounds was never so large or prospects so bright as at present. The exceeedingly



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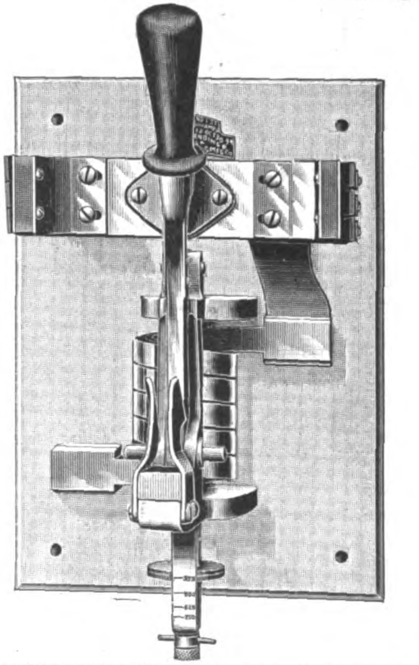

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large business, so rapidly built up by this company, seems marvelous to any one not fully acquainted with the sterling merit of the Dearborn compounds.

The Western Electric Company, New York and Chicago, was represented by Mr. A. L. Tucker, manager of the supply department, Mr. A. M. Little, M. W. Mixer and Thos. G. Grier. This company had a number of advanced sheets illustrating the new apparatus which it is putting on the market. The Western Electric Company is prepared to furnish for the coming year the most approved patterns and latest types of alternating current ceiling and desk motors, direct-current ceiling motors, wall bracket motors, desk and column fans and battery motors. It is unnecessary to remark that with the large representation they had present, nearly every delegate at the convention was informed regarding the new types of apparatus, as well as the line already carried in stock by the Western Electric Company. Manager of supplies, A. L. Tucker, in his quiet, courteous manner, added many new friends and customers to the already large list of the Western Electric Company, while that affable gentleman, Mr. A. McNab Little, did his share in his own peculiar style.

Heysenburg & Badt exhibited, in Parlor 7, samples of the H. & W. Company's supplies, in the shape of a hangerboard, spark arrester, commutator compound, and a composite dynamo brush. They also showed a lamp bank, containing a full assortment of the famous Hardy incandescent lamps, including 220-volt lamps. They also had on exhibition a line of the Weston Electrical Instrument Company's catalogues of all the Weston portable and switchboard instruments, including the famous Round Pattern switchboard, ammeters and voltmeters. These gentlemen also carried a full boxes, ventilating fans, speed regulators, theatre line of the Ward-Leonard Electric Company's circulars describing the well known Carpenter and the Ward-Leonard enamel rheostat starting boxes, ventilating fans, speed regulators, theatre dimmers, standard enamel resistance plates, etc., etc. Edison-Brown plastic rail bonds and elastic copper amalgam bond were also shown. Much interest was evinced by central station delegates in this company's exhibit of Helios lamps, which particular exhibit was looked after by Rohn & Meyer, of Milwaukee, the state agents for Wisconsin. The exhibit was in charge of Professor F. B. Badt and R. F. Schuchardt, of Chicago, assisted by Mr. Wm. Goltz, of Milwaukee.

The Fort Wayne Electric Corporation, of Fort Wayne, Ind., exhibited 110 and 220-volt D. C. arc lamps, and two alternating lamps, one of high and one of low frequency, enclosed type. This company operates alternating enclosed lamps in two different ways: one with an ordinary choke coil replacing the resistance used in D. C. lamps, and one in connection with a special constant-current transformer through which the lamp is operated direct from the primary mains, avoiding by this means all losses usually found in the resistance or choke coil of the lamp. The lamps shown were very ornamental in appearance, being made in several different finishes such as old iron, oxidized copper, oxidized brass, etc. This company also exhibited a line of meters embracing various sizes and voltages adapted for the variety of purposes to which meters are put

One of the nice features of one of the meters shown is the variable friction compensator with which it is equipped. This provides for the elimination of increasing friction brought about by constant use usually resulting from the jewels becoming rough. Another nice feature is its accuracy in voltages within a wide range from normal and still maintaining its straight line characteristic. These meters are dust and insect proof, and are provided with everything necessary to prevent tampering by meddlesome customers. The latest feature in the meter is the adoption of the new kilowatt hour reading dial. The exhibit was in charge of Messrs. F. S. Hunting, Thomas Duncan and A. L. Draffe.n

The Wagner Electric Company St. Louis, had its exhibit in charge of salesman manager, E. H. Abadie, assisted by Mr. J. H. Perkins. They exhibited a 15-HP alternating current, single-phase induction motor, belted to a 15-KW D. C. 110-volt generator. The 15-HP induction motor was operated from a standard 200-light, type G transformer. The Wagner Company connected in circuit 100-volt lamps and demonstrated the practicability of operating their single-phase induction motors on the same circuit and from the secondary of the same transformer, without detriment to the lighting service. This company also had in circuit on the secondary side, one of the illuminated dial, dead beat station voltmeters. Several of this company's new type of transformer were exhibited, and a 30-lt. type F.; an 80-lt. type G and a 40-lt. type F.; also a line of switches and tablet boards and special pole or line switch. They had in addition a number of photos showing the general construction of case and core of a 40,000-volt transformer of 330-KW capacity, constructed for a transmission plant in Utah, which plant proposes by means of this apparatus to transmit current 54 miles from the source of generation, to be utilized for lighting and motor work; also general views of the factory and of 3 D C. 110-volt slow-speed motors of 5-, 7½- and 15-HP capacity, which they recently sold to Messrs. Rohn & Meyer, Milwaukee, for installation in the Baltz Hotel, Milwaukee. A very handsome souvenir was also distributed in the form of a calendar comprising photos of the various specialties manufactured by the Wagner Company.

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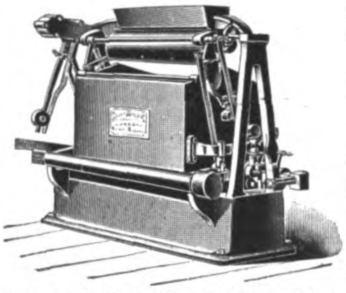
January 1, 1898.

Notice is hereby given that the copartnership heretofore existing between the undersigned, under the firm name of Herrick & Burke, has expired by limitation.

Mr. Herrick and Mr. Burke individually will continue to devote themselves to the practice of electrical engineering, and their address will remain No. 150 Nassau Street.

Signed: ALBERT B. HERRICK.
JAMES BURKE.



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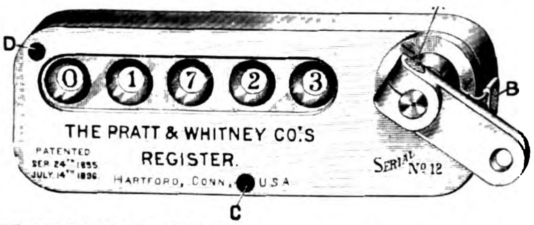

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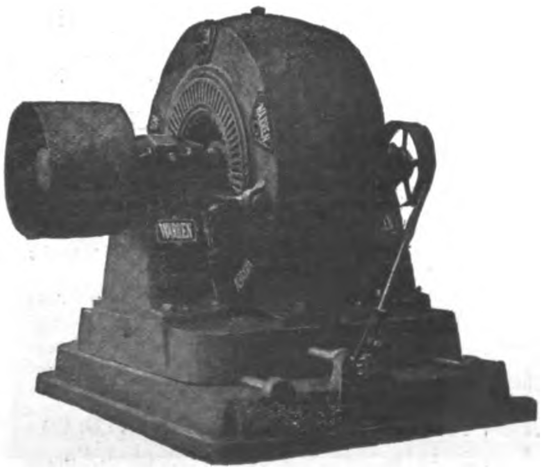

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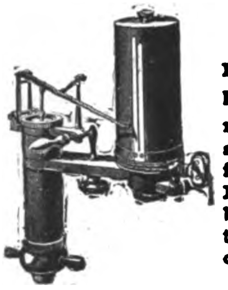

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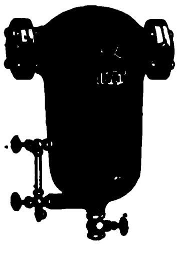

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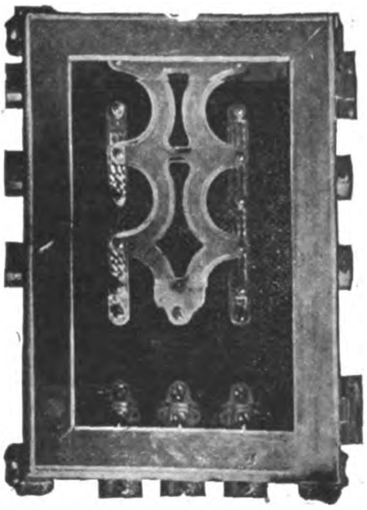

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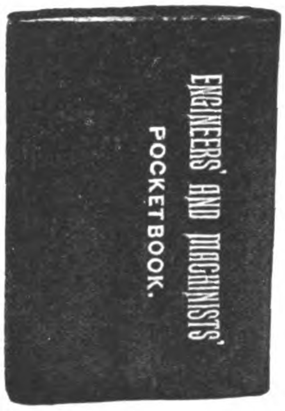

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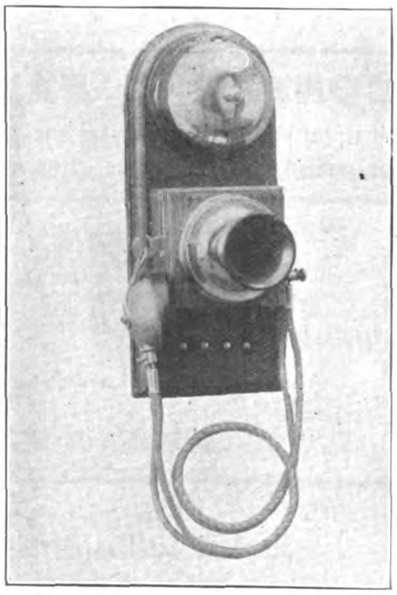

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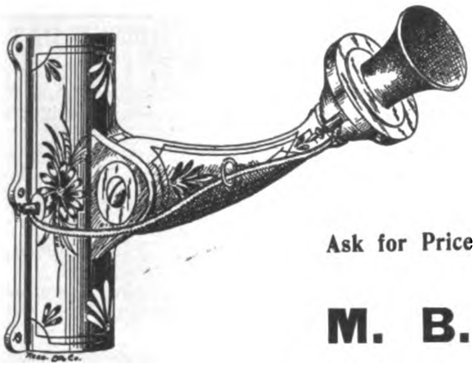

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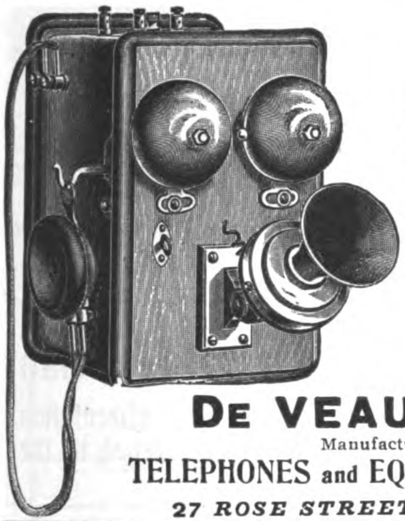

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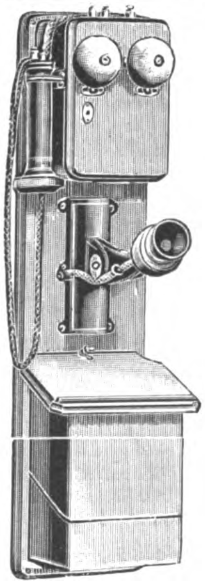

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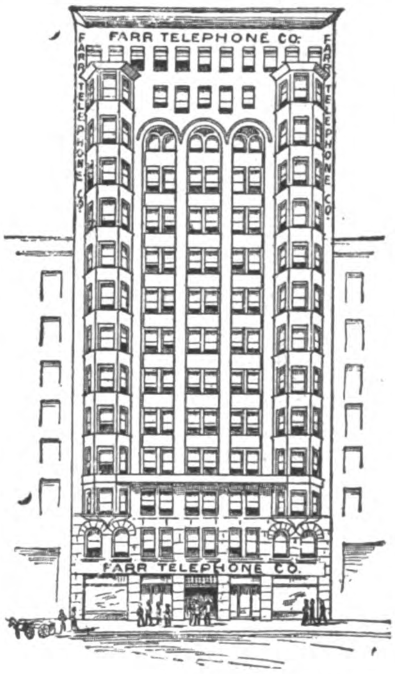

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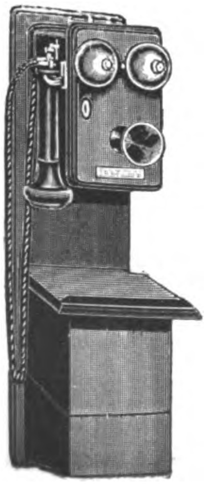

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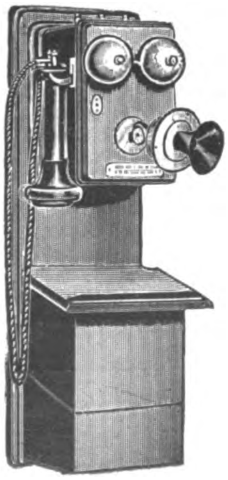

CLASSIFIED LIST OF ELECTRICAL BOOKS.

Any book on this list (or any electrical book in print) will be sent, post paid, upon receipt of price.

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Badt's New Dynamo Tender's Handbook. 226 pages. 140 illustrations. Price, $1.

Contains instruction for the management of dynamos, correction of troubles, etc,

Bottone's How to Manage a Dynamo. 66 pages, 9 illustrations. Price, 60 cents.

An English work intended by the author for the use of stationary and marine engineers who may find themselves suddenly called upon to undertake the management of a dynamo.

Crocker and Wheeler's Practical Management of Dynamos and Motors. Fourth edition. 206 pages, 99 illustrations. Price, $1.

A practical manual on the operation of dynamos and motors. the localization and remedy of faults, testing, etc. The opening chapters explain the principles and construction of dynamos and motors, methods of installation, etc. The final chapters are on machines requiring special directions for operation, such as the T.-H.

Desmond's Electricity for Engineers. 424 pages, 131 illustrations. Price, $2.50.

Contains descriptions of various types of continuous and alternating-current machinery, with simple explanations of principles.

Gibbing's Dynamo Attendants and Their Dynamos. 58 pages, 14 illustrations. Price, 50 cents.

A practical book on the management of dynamos, written by the electrical engineer of an English municipal lighting plant.

Guy's Electric Light and Power. 352 pages, 47 illustrations. Price, $2.50.

Gives the author's experience of several years in English central-station work, with practical explanations of elementary electrical principles.

Lummis-Patterson's Management of Dynamos. 214 pages, 81 illustrations. Price, $1.50.

An English book on the elementary principles of the dynamo, with practical directions for its management.

20

MacFadden and Ray's Practical Application of Dynamo-Electric Machinery. 167 pages, 38 illustrations. Price, $1.

Gives simple explanations of elementary electrical principles, and describes various types of commercial apparatus.

May's Electric Light Plant. Price, $1.

An English book of instructions for the operation of electric-lighting plants.

Paterson's Management of Dynamos. 214 pages, 81 illustrations. Price, $1.

A handbook, by an English author, intended for the use of those in charge of dynamos. Also contains simple explanations of electrical principles.

Regan's Handbook of the Brush Arc System. Price, $1.

Includes a revolving mica representation of a Brush commutator, whereby the principle of the Brush type of dynamo may be easily understood.

Stephen's Wrinkles in Electric Lighting. 45 pages, 23 illustrations. Price, $1.

An English book of practical information on the management of dynamos, etc.

The AMERICAN ELECTRICIAN contains in every number articles relating to the operation of central station, electric railway, and isolated electric lighting plants. One of its features consists of articles and notes on practical expedients, apparatus and line repairs, detection and remedy of faults, etc.

21

ELECTRICAL MEASUREMENTS.

Bottone's Electrical Instrument Making for Amateurs. 175 pages, 48 illustrations. Price, 50 cents.

Contains instructions for making simple electrical apparatus.

Carhart and Patterson's Electrical Measurements: A Laboratory Manual. 344 pages, 142 illustrations. Price, $2.

Intended for college use, but answers many of the purposes of an industrial treatise.

Crapper's Practical Electrical Measurements. 125 pages, 56 illustrations. Price, 75 cents.

An elementary text-book, intended more particularly for school instruction.

Everett's Units and Physical Constants. 200 pages. Price, $1.25.

An authoritative compilation of physical constants and systems of units used in physical science, including electricity and magnetism. For electricity the constants for specific resistance, specific inductive capacity, contact and thermo-electric differences of potential, electrochemical equivalents, etc., are given.

Frey's How to Use Electric Measuring Apparatus. Price, 50 cents.

A manual of practical information relating to electrical testing.

Haskin's Galvanometer and Its Uses. 74 pages, 8 illustrations. price, $1.50.

Describes apparatus and gives some information concerning principles and practice of electrical measurement.

Houston's Measurement of Electric Currents, and other Advanced Primers of Electricity. 429 pages, 169 illustrations. Price, $1.

Contains simple explanations of the various methods of measuring electrical currents, E. M. F., resistance, etc., with descriptions of apparatus. Intended for popular reading and for use by beginners in obtaining familiarity with the first conceptions of electrical science.

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Kempe's Handbook of Electrical Testing. Fifth Edition. 576 pages, 200 illustrations. Price, $7.25.

The standard English treatise on electrical testing. Deals principally with telegraph, cable and laboratory testing.

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A comprehensive treatise on the voltaic cell, both primary and secondary batteries being included under that term. The various accepted theories are explained and discussed, and the construction and action of all the more important cells described.

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Gives the theory of primary battery in simple language and describes the various practical forms of cells. A very satisfactory treatise on the subject.

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The best elementary treatise on the modern theory of voltaic cells and of electrolysis.

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ELECTRO-PLATING.—ELECTRO-CHEMISTRY.

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An elementary manual for amateurs and young students.

Gore's Art of Electrolytic Separation of Metals. 301 pages, 106 illustrations. Price, $3.50.

Deals with the principles concerned in the electrolytic separation of metals and with their practical application on a commercial scale. An English work.

Gore's Theory and Practice of Electro-Deposition. 132 pages, 35 illustrations. Price, 80 cents.

Contains practical instructions for carrying out the various processes involved in electro-plating.

Langbein and Brannt's Electro-Deposition of Metals. 458 pages, 138 illustrations. Price, $4.

A full and practical treatise on electro-plating, the deposition and coloring of metals, with descriptions of the electrical apparatus employed. An American work.

Lupke's Elements of Electro-Chemistry Treated Experimentally. Price, $3.

A translation from the German.

McMillan's Treatise on Electro-Metallurgy. 387 pages, 101 illustrations. Price, $3.50.

A technical manual on electro-plating, electrotyping, electro-deposition, and electro-metallurgical extraction and refining processes. The treatment of the various subjects is practical and detailed, and in a glossary the various chemicals and substances used in the different processes are described and directions given whereby their purity may be tested.

Urquhart's Electro-Plating. 226 pages, 24 illustrations. Price, $2.

A compilation of practical information on the deposition of metals, with descriptions of apparatus.

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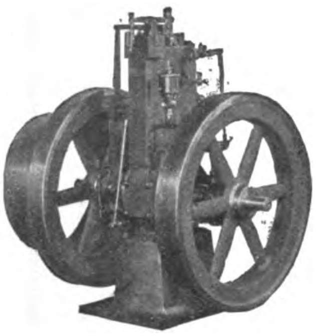

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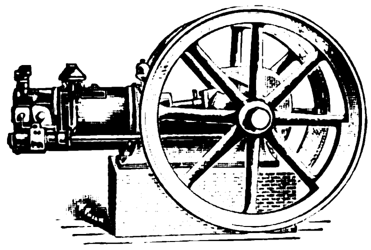

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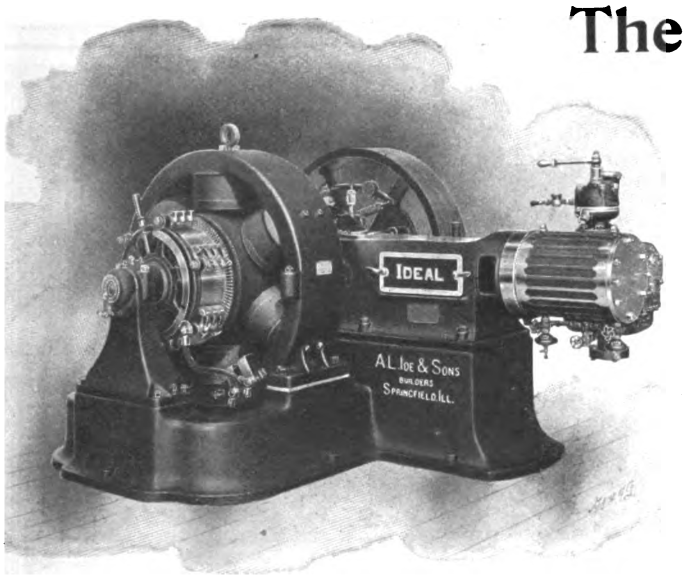

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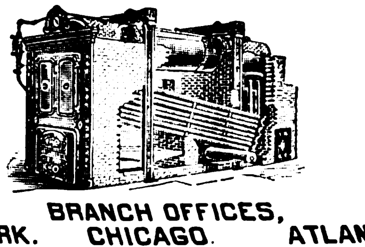

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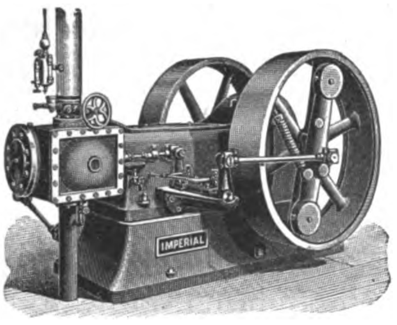

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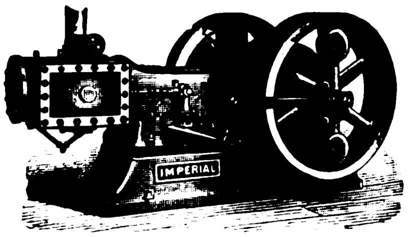

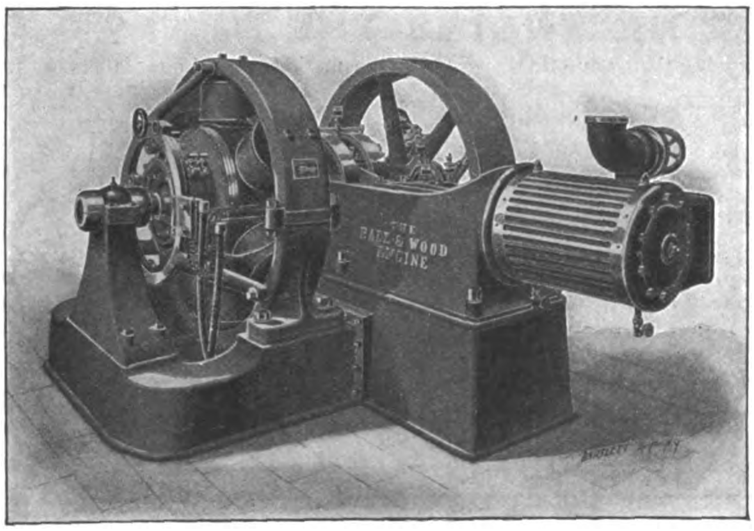

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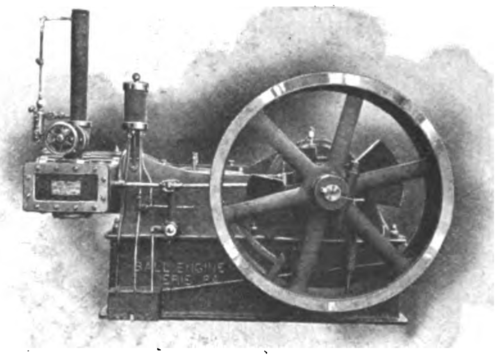

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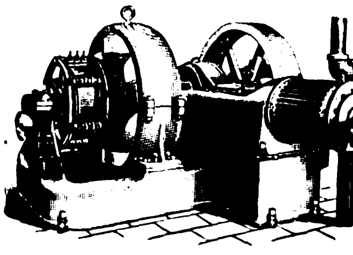

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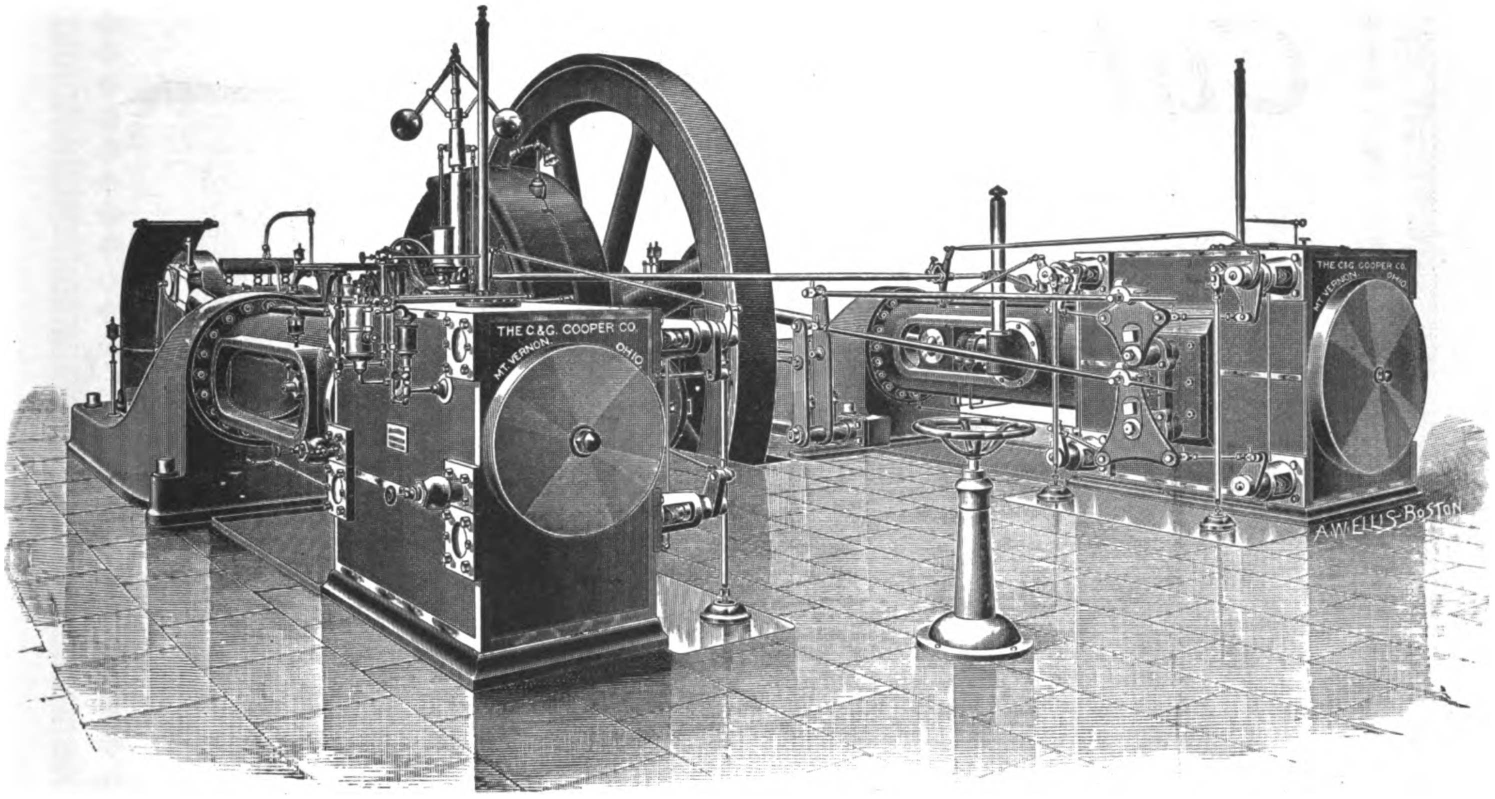
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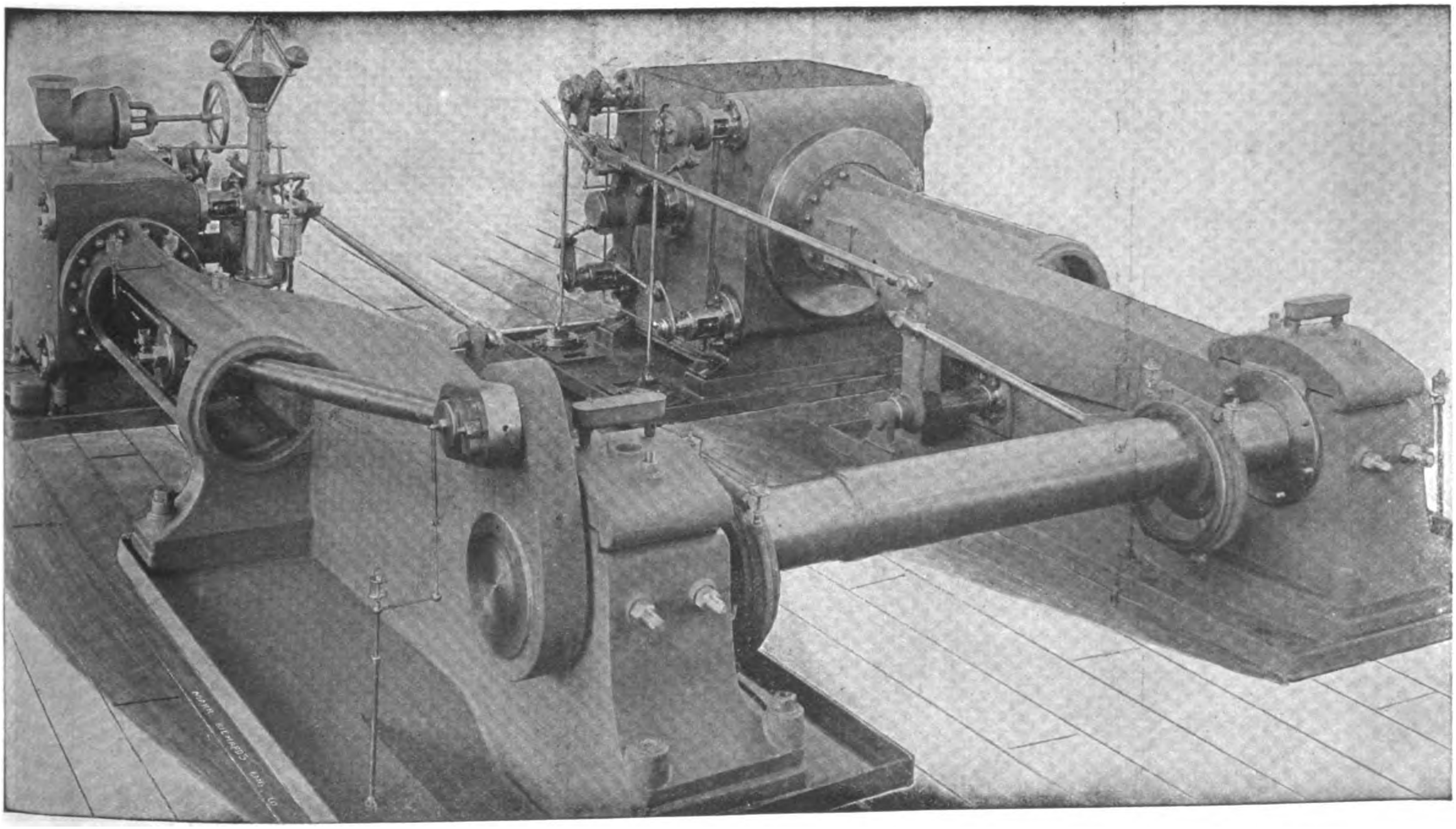

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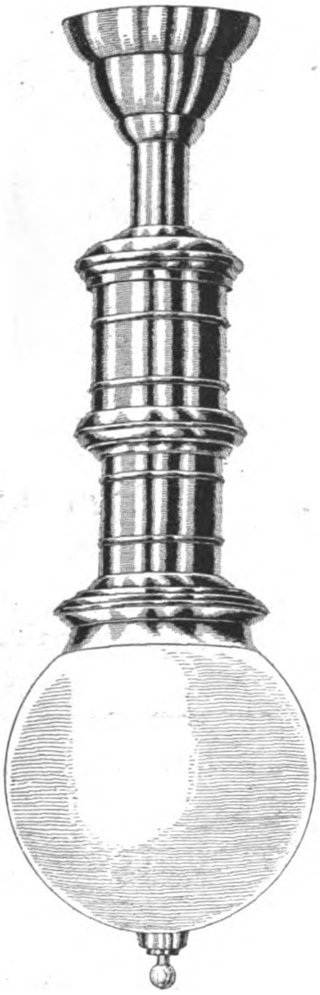

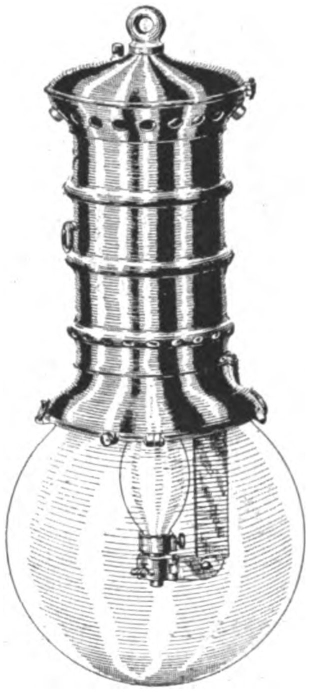

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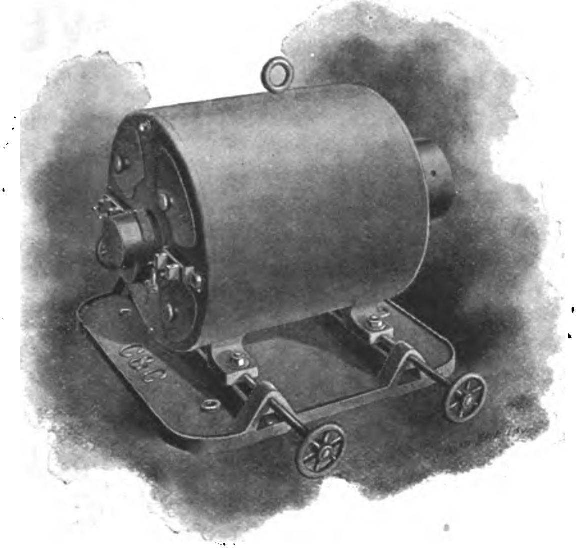

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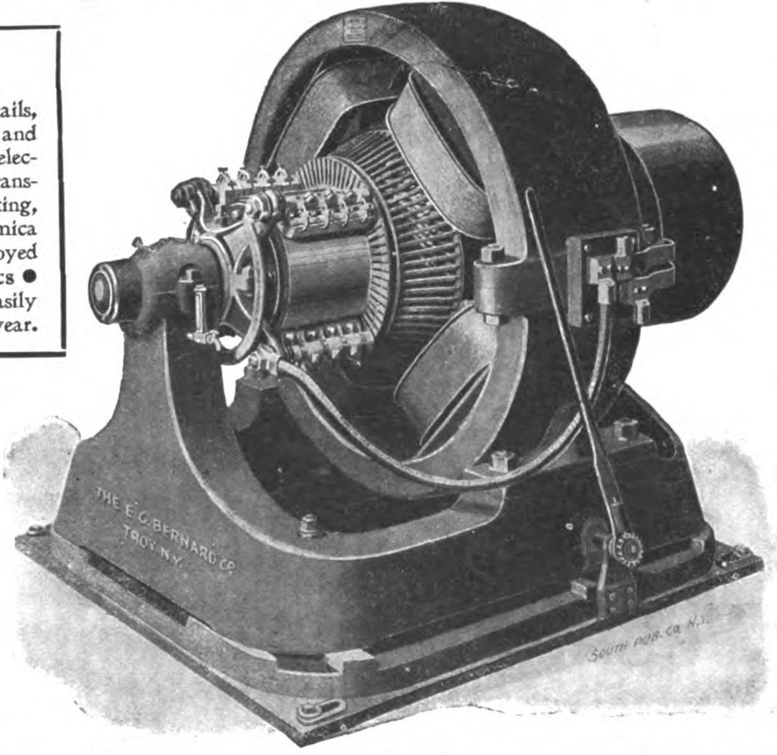
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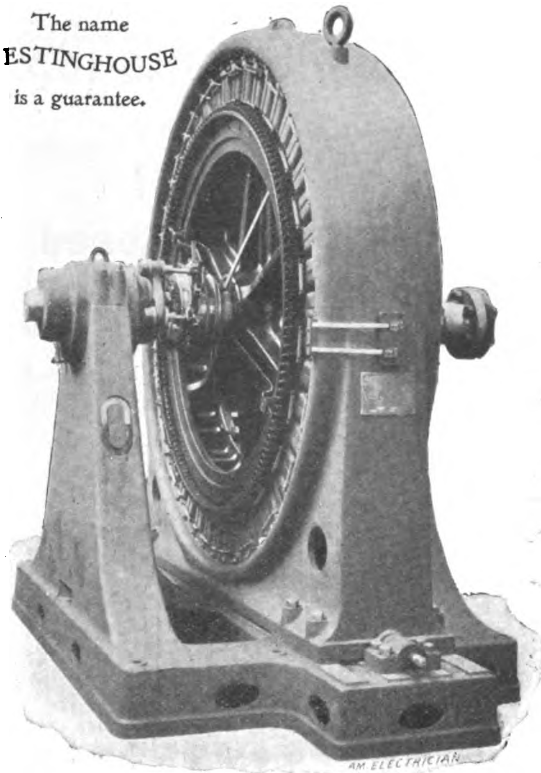

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3—5000 H. P. Generators, Niagara Falls Power Co., in operation.

2—5000 H. P. Generators, Niagara Falls Power Co., being installed.

3—5000 H. P. Generators, Niagara Falls Power Co., under construction.

These are twice as large as the largest Generator ever put in service elsewhere.

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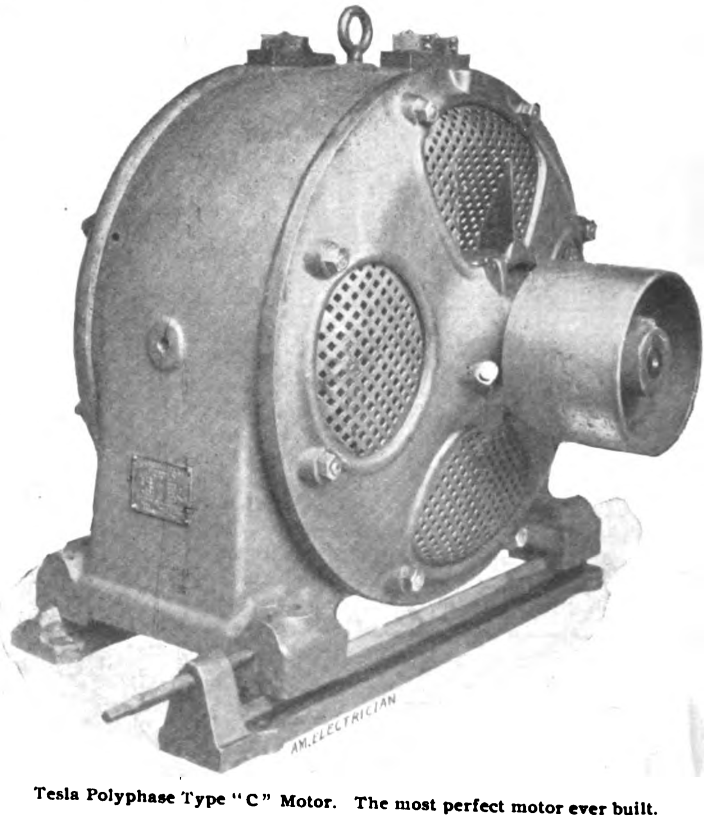

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Transformer Economy

The Diagram shows part of the map of Conshohocken, Pa., where **25 Small Transformers** (●) were replaced by **2** of our **Type H** (■) Transformers.

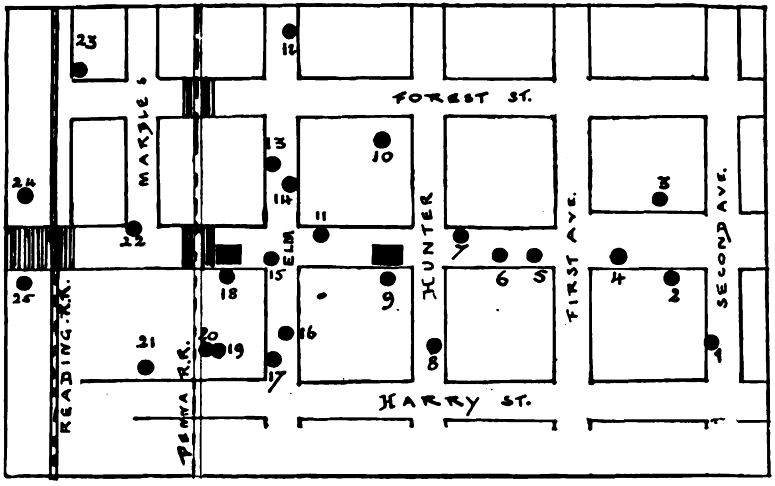
The table shows the actual performance of these Small Transformers.

The Result of the Change:

Core loss of 25 Small Transformers	1664
Core loss of the 2 Type H Transformers	238
Saving in Watts -	**1426**

You cannot afford to continue the use of old, small, individual Transformers, when a change to new methods will bring about such results.

It will pay you to use **Type H Transformers.** You can operate your plant with less Coal, with greater safety, with better regulation, and increase the station capacity by the amount saved in core losses.



THE CHANGE AT CONSHOHOCKEN, PA.

Location See Diagram	Transformer Capacity 16 C.-P. Lamps	16 C.-P. Lamps Connected	Watts Core Loss
1	40	14	127
2	10	5	55
3	5	5	41
4	5	9	48
5	20	9	87
6	20	14	98
7	10	9	58
8	30	15	97
9	20	18	98
10	10	10	56
11	5	5	49
12	30	20	98
13	10	1	46
14	10	10	49
15	5	2	52
16	5	6	62
17	10	10	54
18	10	18	51
19	10 }	18	58
20	10 }		56
21	5	5	47
22	10	8	50
23	5	5	46
24	40	35	133
25	5	9	48
	340	257	**1664**

Core Loss of the two Type "H" Transformers - - - - - - 238

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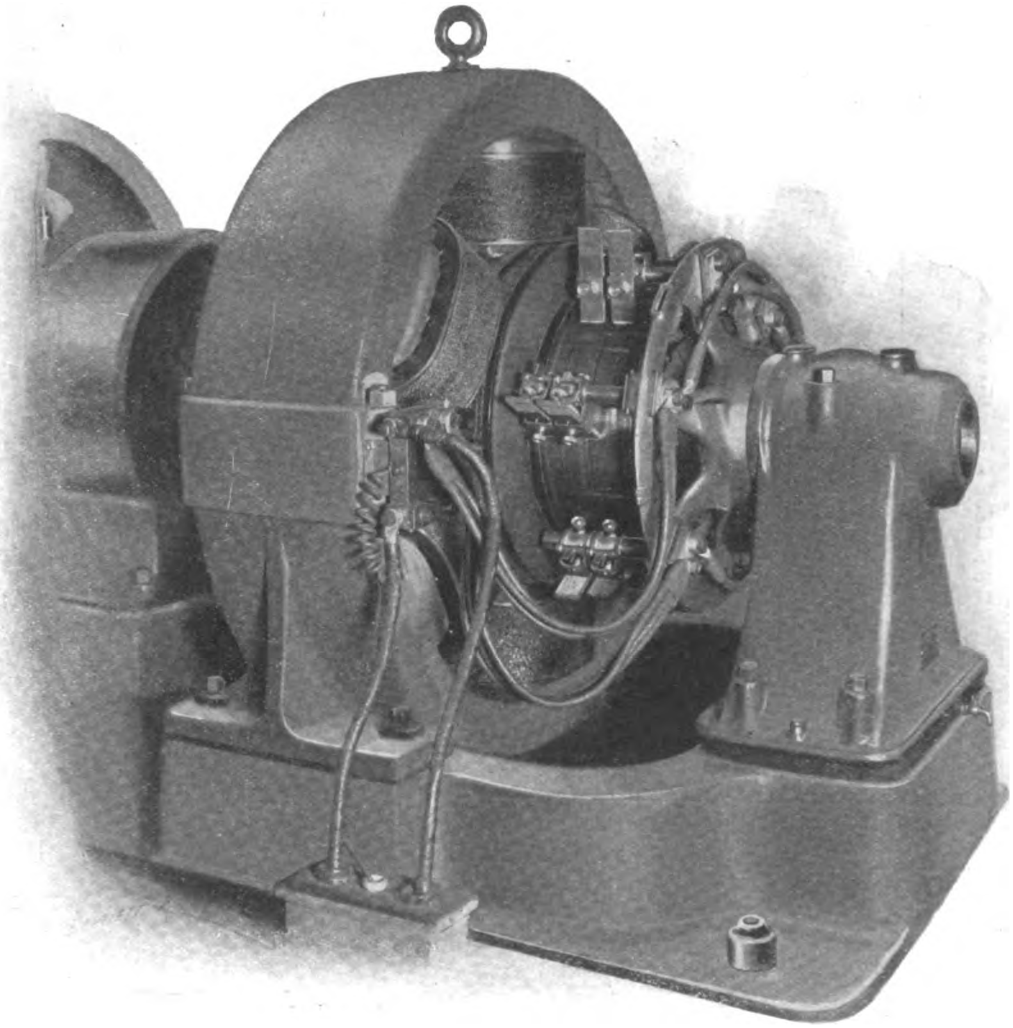

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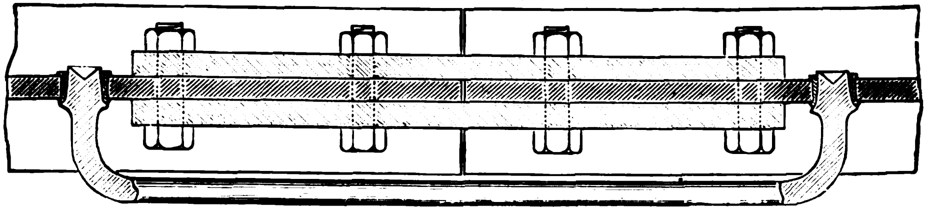

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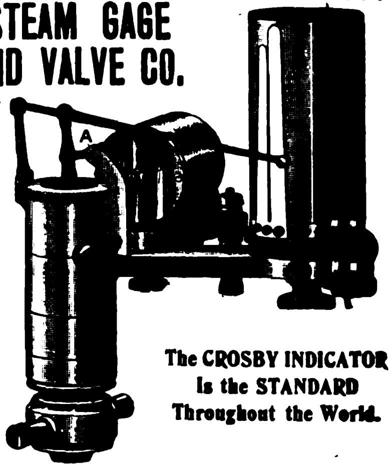

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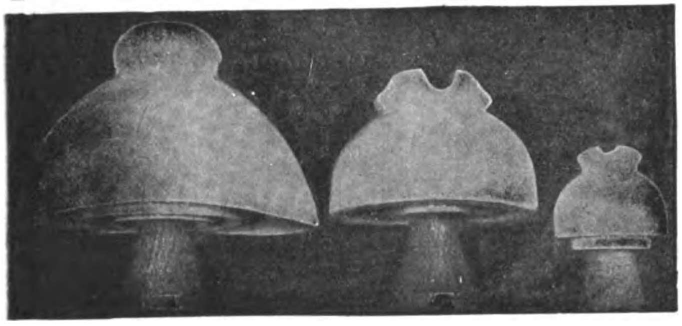

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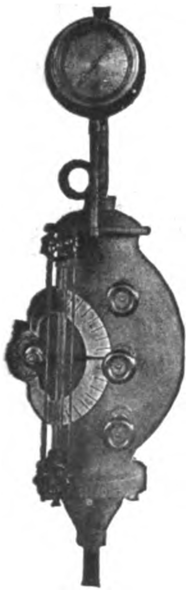


FIG. 1.

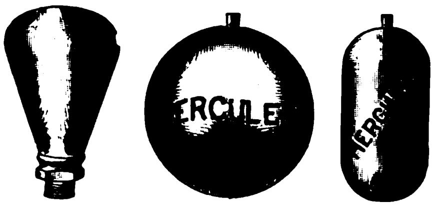
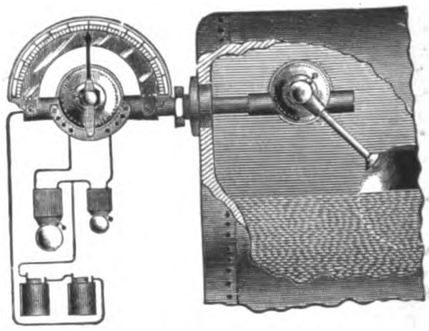


FIG. 2.



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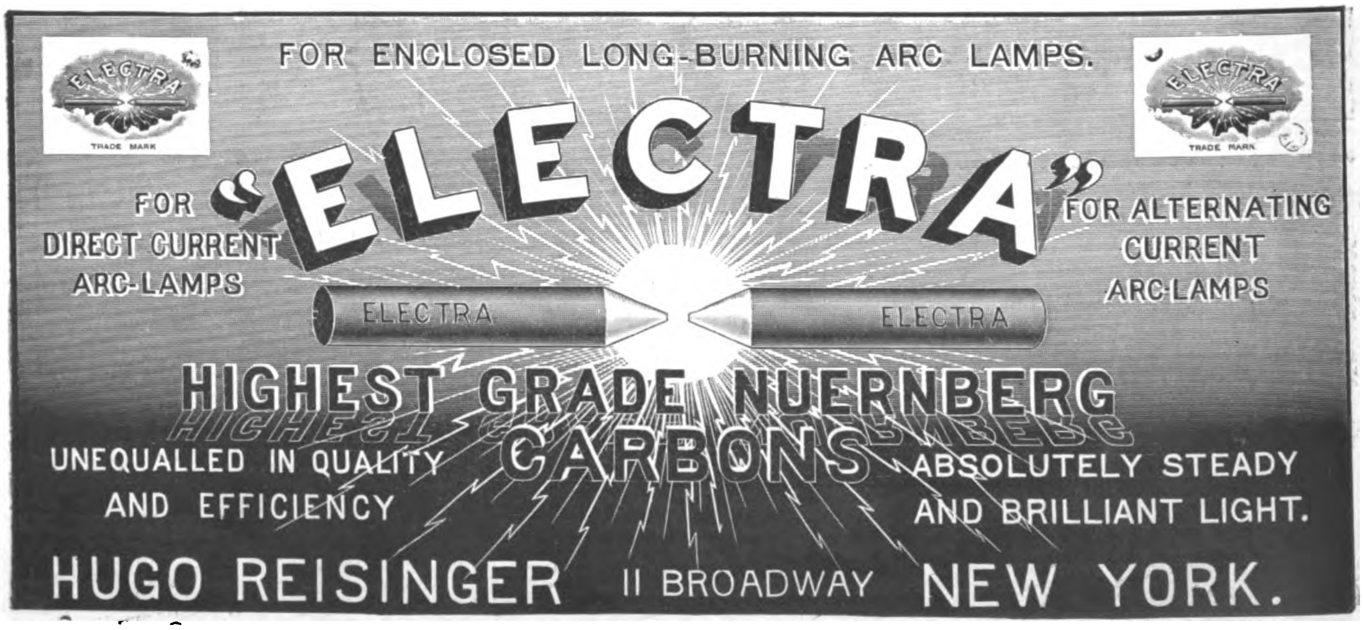

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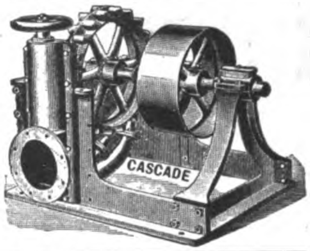

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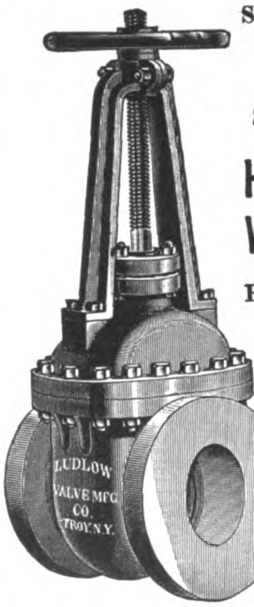
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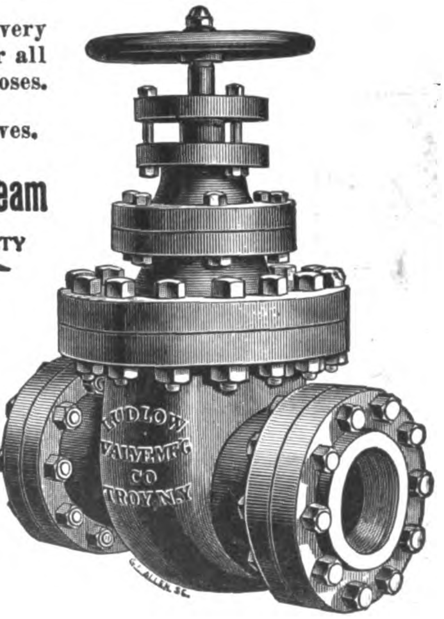
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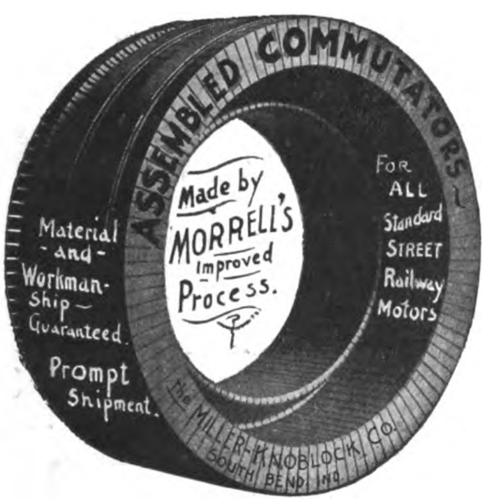
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American Electrician.

Vol. X. New York, March, 1898. No. 3.

WATER-POWER LIGHT AND POWER PLANT FOR A SMALL TOWN.

DELTA LIGHT AND POWER PLANT.

BY S. H. DAILEY.

While the water power electrical generating plant described herewith is not one of large power, it is notable for excellent design and the efficient manner in which all of the local conditions have been met, both with respect to generation and distribution.

The town of Delta, which the plant supplies with light and power, is located in the extreme southeast corner of York County, Pennsylvania. The stream—Muddy Creek—which supplies the power, drains the entire southeast section of York County, and even in the dryest season has a sufficient supply of water to furnish 1000 h.p. for a ten-hour daily run.

The power house is situated near what was at one time a natural waterfall of 20 ft., now covered by the dam.

Figs. 1 and 3 give a general view of the power house and dam. The location is an ideal one for the plant, having the advantage of bedrock for foundations of building and machinery, as also for an anchorage for the dam. At present, having only been in operation a few weeks, the power is being used in Delta for commercial and street lighting, running a pump for town water supply, furnishing power to a planing mill, printing office and other manufactures. As soon as the weather permits extension of the transmission lines, power will be furnished to the slate quarries in the vicinity, which are the largest roofing slate quarries in the country.

The dam is built on the crib pattern, being 35 ft. wide at the base, and 130 ft. at top, having a height of 41 ft. White and rock oak timber, 10 to 15 ins. square, securely pinned together with ⅞ in. square iron pins, is used for the cribbing, the foundation timbers being bolted to bedrock and those of the ends meeting solid rock, where they are firmly anchored. Fig. 3 shows the top of the dam.

The plan of the dam is that of a V of an angle of 160°, the apex of which points up stream. With the natural anchorage afforded it at the ends, there is, therefore, little fear of its ever giving any trouble. The down-stream section has a batter of 7 ft. The crib is closely packed with broken stone. The face is planked with 2½ in. white oak, and to further prevent leakage these planks are covered with 1 in. boards, while beyond this is a filling of stone, gravel and earth, extending 30 ft. up stream and rising 45 ft. on the face of the dam. The top is covered with 3½ in. oak plank, laid ½ in. apart to allow water to keep the cribbing wet.

In order that the water may be drawn off at any time, there is a steel discharge pipe 4 ft. in diameter, with gate, placed near the bottom, and running from back through the filling on the face. The storage capacity is estimated at 39,600,000 cubic ft. of water.

The power house is 22 ft. by 44 ft, and is built of stone laid in Portland cement, and faced with the same inside and out. It is two stories high, the first or ground floor being in one room, and occupied by the power machinery and generator. A general view of the interior is given in Fig. 4. The second story is divided into store room and living apartments for employees. The foundations are laid on bedrock.

The turbines, of which there are a pair, are of the McCormick type, as manufactured by S. Morgan Smith, of York, Pa.

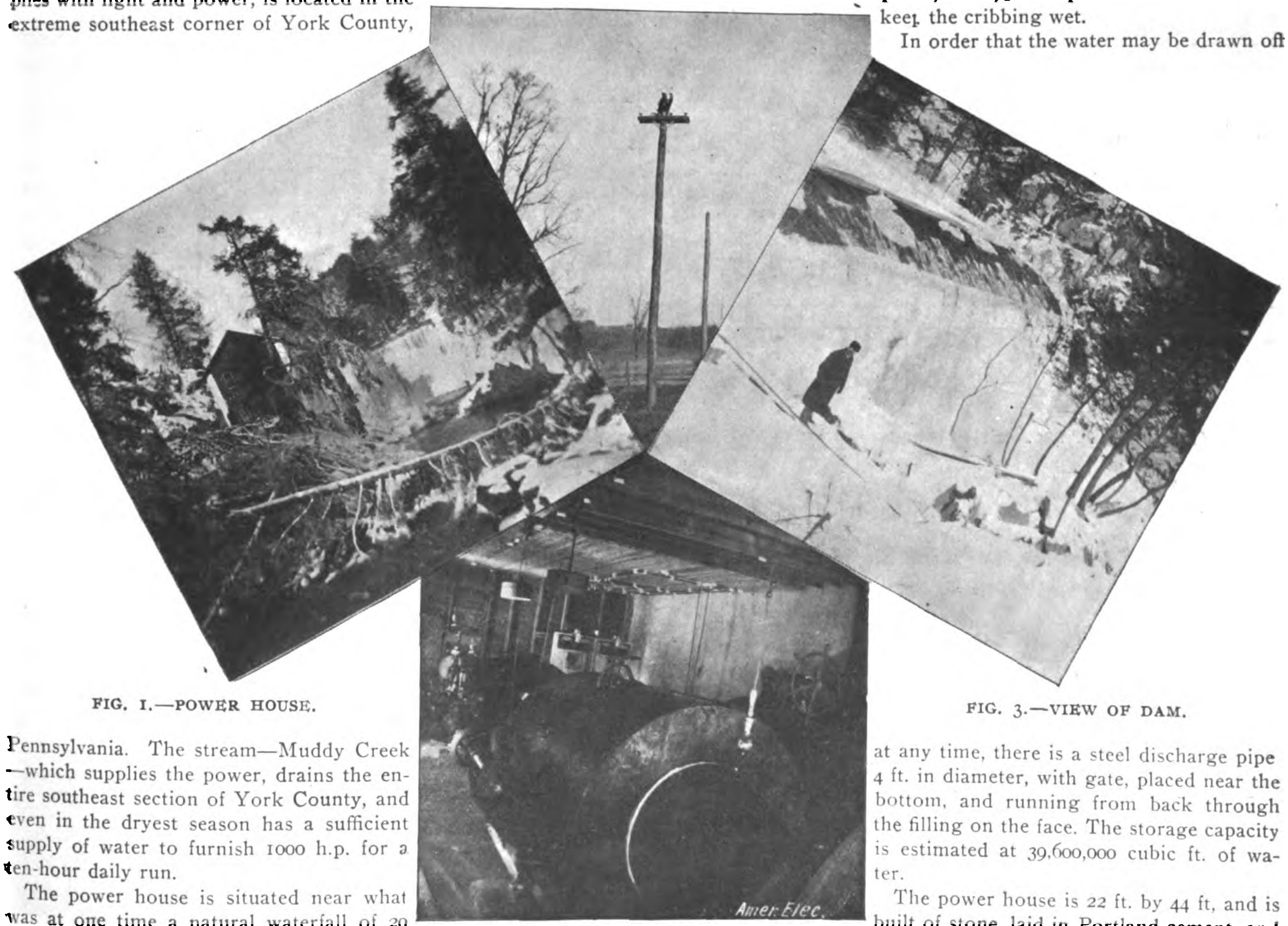
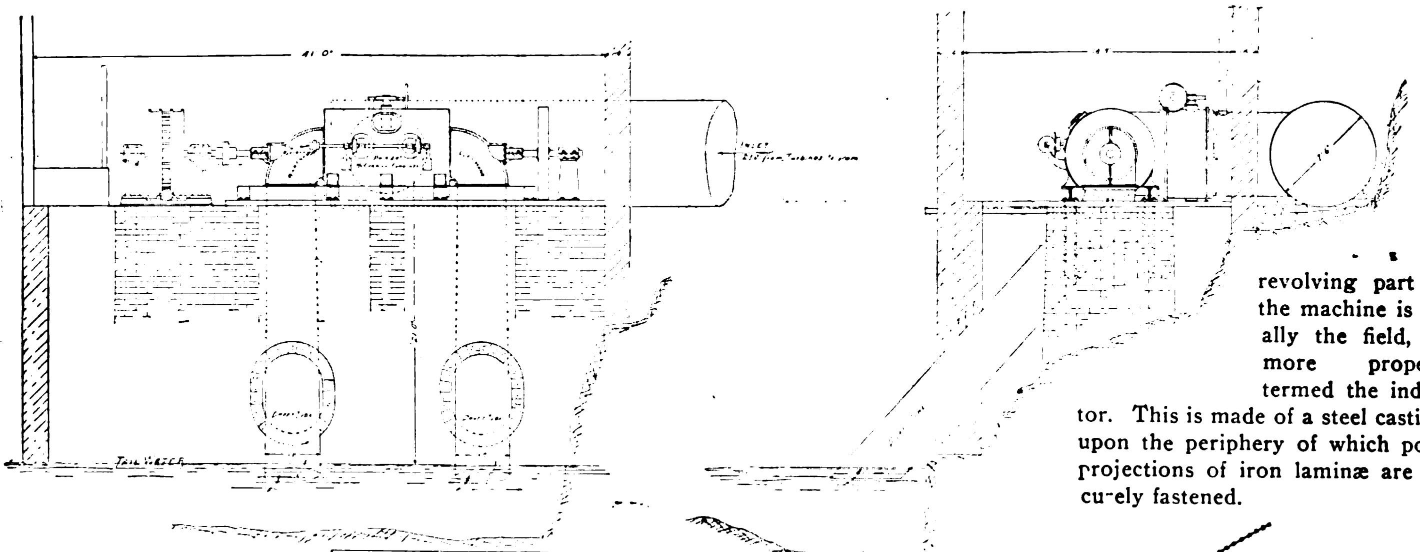


FIG. 1.—POWER HOUSE.

FIG. 2.—POLE LINE.
FIG. 4.—GENERATING ROOM.

FIG. 3.—VIEW OF DAM.

They are 24 ins. in diameter, and located one-half way between the surface of the water in the dam and the tail water, and with a 42 ft. head and 400 r.p.m., develop 575 h.p. As the general plan shows, the turbines are supplied with water from the dam, 250 ft. distant, by a steel tube 7 ft. 6 ins. in diameter, near the end of which, at right angle, is tapped a branch tube 6 ft. in diameter, leading direct to wheel casings. This 6 ft. tube is supplied with a gate valve in order that No. 1 wheel may be cut off from the supply pipe without affecting a second set of wheels, which will be installed at a later date. From the wheels the water is carried to the tail race by draft tubes 48 ins. in diameter. The efficiency of these wheels is rated by the makers at 85 per cent.



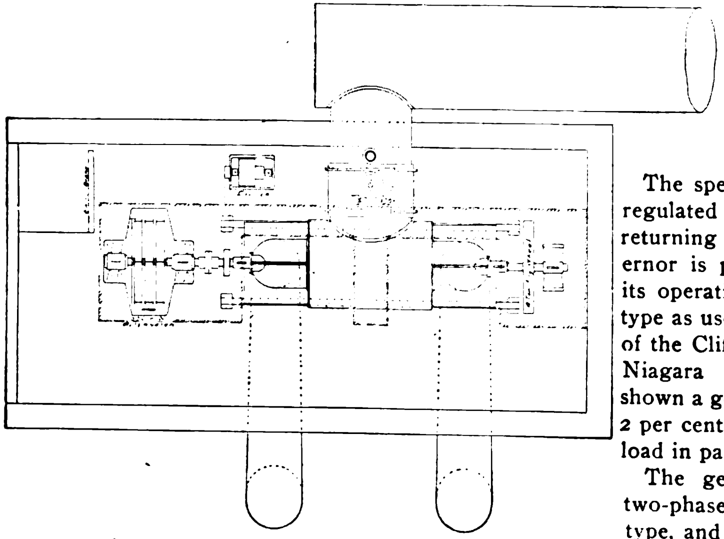


FIG. 6.—PLAN AND SECTIONS OF POWER HOUSE.

The speed of the turbines is regulated by a Replogle relay returning governor. This governor is purely mechanical in its operation and of the same type as used in the power house of the Cliff Paper Company at Niagara Falls, where it has shown a governing efficiency of 2 per cent from full load to no load in particularly severe tests.

The generator was of the two-phase alternating current type, and was furnished by the Stanley Manufacturing Company, of Pittsfield, Mass. It is designed to generate 350 k.w. at 5600 volts, with 800 alternations and a speed of 400 r.p.m. The generator is direct-connected to the shaft of the turbines by a flexible coupling. Fig. 10, showing the generator armature drawn out, gives a complete idea of the construction of the generator, showing, as it does, that simplicity and strength are striking characteristics—the wearing parts being only two journals. It has no moving wire, no collector rings and no commutator. The revolving part of the machine is really the field, but more properly termed the inductor. This is made of a steel casting, upon the periphery of which polar projections of iron laminæ are securely fastened.

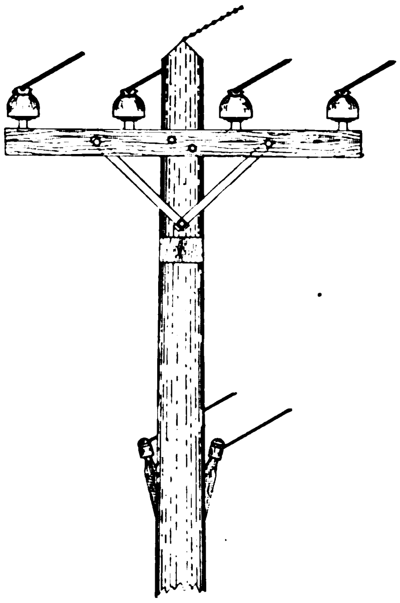


FIG. 5 —TRANSMISSION POLE.

The armature is made up of laminæ of iron, and the individual coils, wound separately on forms, are secured in grooves provided for them in the laminations.

The armature and field wires are brought out from the machine to a terminal board (Fig. 9), consisting of two heavy slabs of marble fastened to the machine. Owing to

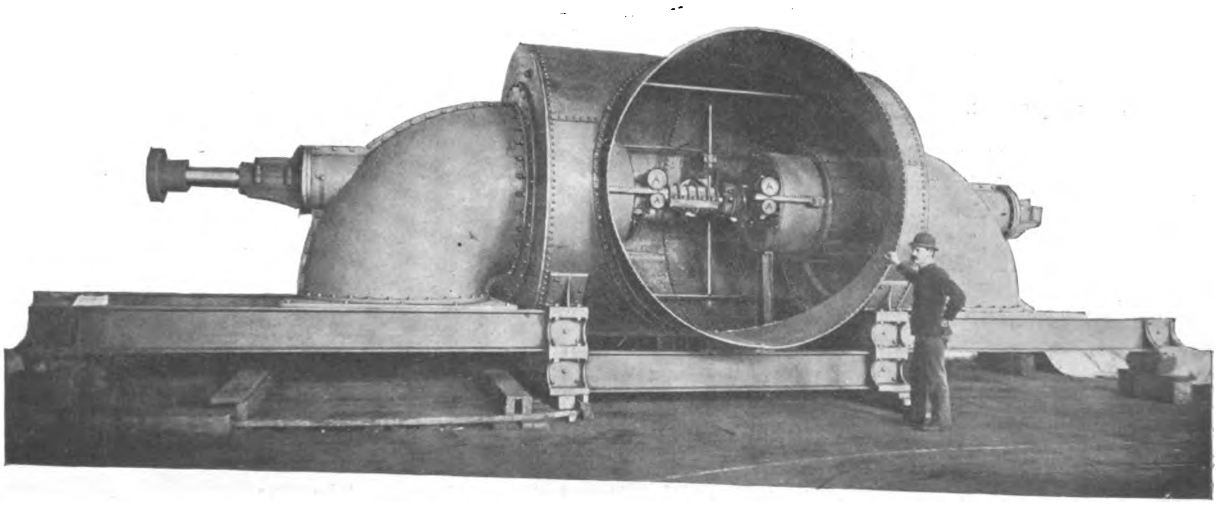


FIG. 7.—TWIN TURBINE.

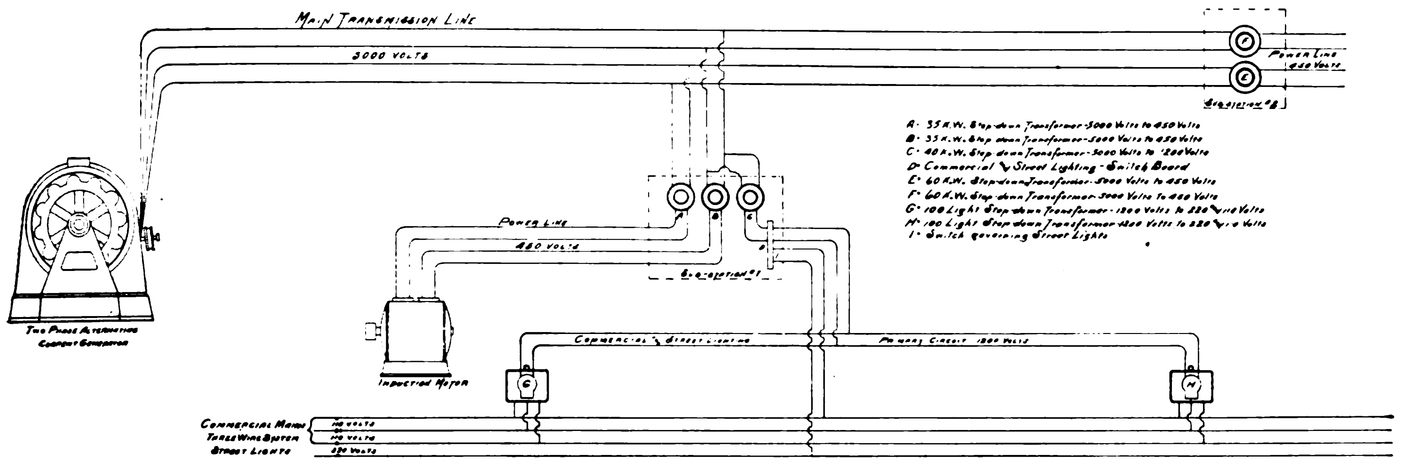

Main Transmission Line
3000 Volts
Power Line
450 Volts
Sub-station No. 2
A · 35 K.W. Step-down Transformer-5000 Volts to 450 Volts
B · 35 K.W. Step down Transformer-5000 Volts to 450 Volts
C · 40 K.W. Step-down Transformer-5000 Volts to 1200 Volts
D · Commercial & Street Lighting-Switch Board
E · 60 K.W. Step-down Transformer-5000 Volts to 450 Volts
F · 60 K.W. Step-down Transformer-5000 Volts to 450 Volts
G · 100 Light Step-down Transformer-1200 Volts to 220 & 110 Volts
H · 100 Light Step-down Transformer-1200 Volts to 220 & 110 Volts
I · Switch governing Street Lights
Power Line
450 Volts
Sub-station No. 1
Two Phase Alternating Current Generator
Induction Motor
Commercial & Street Lighting
Primary Circuit 1200 Volts
Commercial Mains
Three Wire System
Street Lights
110 Volts
110 Volts
220 Volts
A
B
C
D
E
F
G
H

FIG. 8.—DIAGRAM OF CIRCUITS.

the wide differences of loss in different lines and difficulty in balancing the load on different circuits, the E. M. F. of either of the two currents may be varied independently of each other by merely turning a handle at the terminal board one way or the other.

From this board the wires are led to the switchboard, which is of white marble and fitted with all the necessary switches, volt and ammeters, etc., a panel for each side of the machine.

The switches, current breakers, etc., are of a superior grade, and made absolutely safe for handling a current of such high voltage.

The static ground detector, Fig. 12, is used on this board, one on each side, and is fully described in AMERICAN ELECTRICIAN February, 1897. The exciter is of the multipolar type. From the power house to sub-station No. 1 is five miles, this being the length of the transmission line completed; it will, however, be extended 1.75 miles, to sub-station No. 2, as soon as the weather permits.

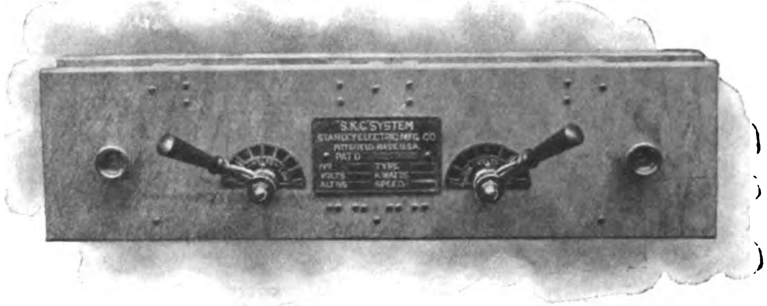

S.K.C. SYSTEM
STANLEY ELECTRIC MFG. CO.
PITTSFIELD, MASS. U.S.A.
PAT'D
KW
VOLTS
ALT'NS
TYPE
AMPS
SPEED

FIG. 9.—GENERATOR TERMINAL BOARD.

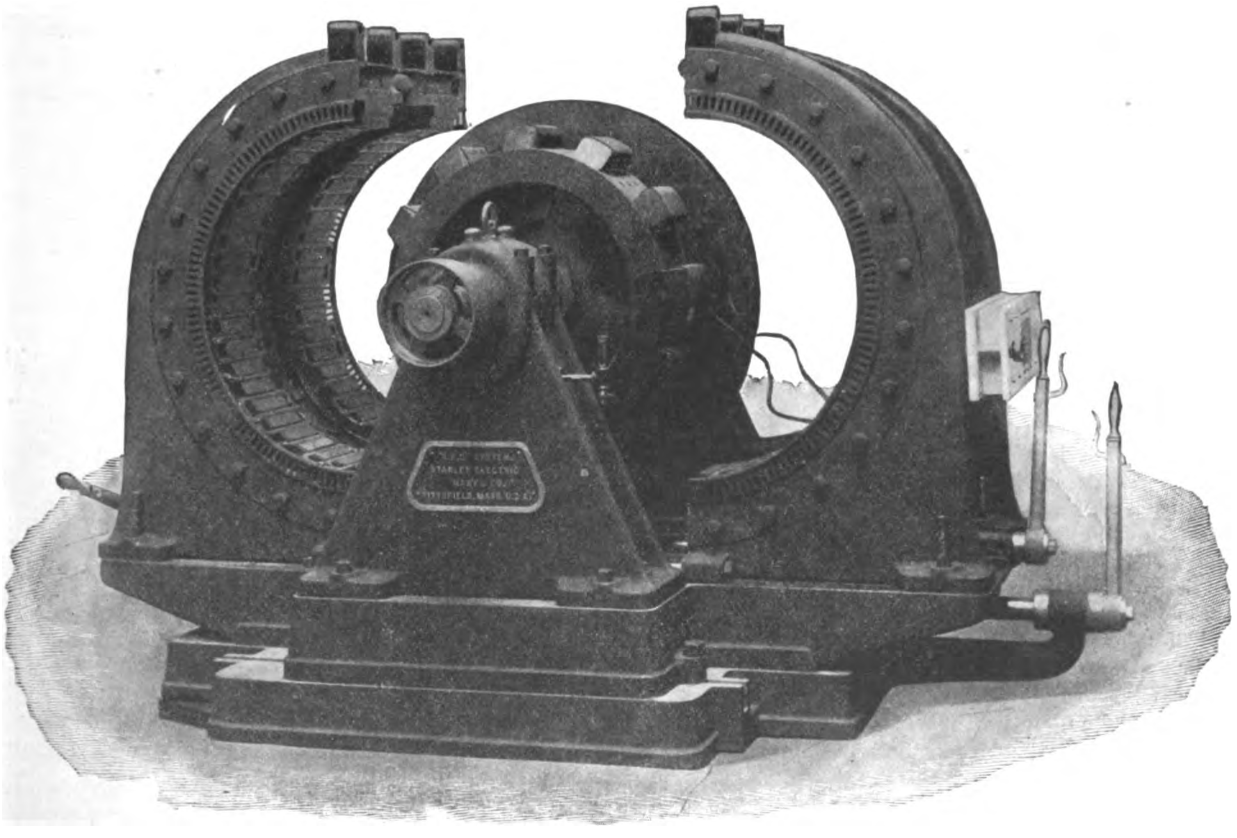


FIG. 10.—TWO-PHASE GENERATOR.

Chestnut poles are used, varying in length from 28 ft. to 40 ft., with a minimum diameter of 7 ins. at the top They are set 5 ft. in the ground, and all poles not in line are securely anchored or guyed with ¼ in. galvanized steel cable. The distance between poles in line is 100 ft., but at curves or at a turn, this distance is reduced, being 80 ft. in some cases and 90 ft. in others.

The cross-arms are of yellow pine, 5 ft. x 4¼ in. x 3¼ in., with locust pins, carrying four No. 4 B. & S. gage soft-drawn copper

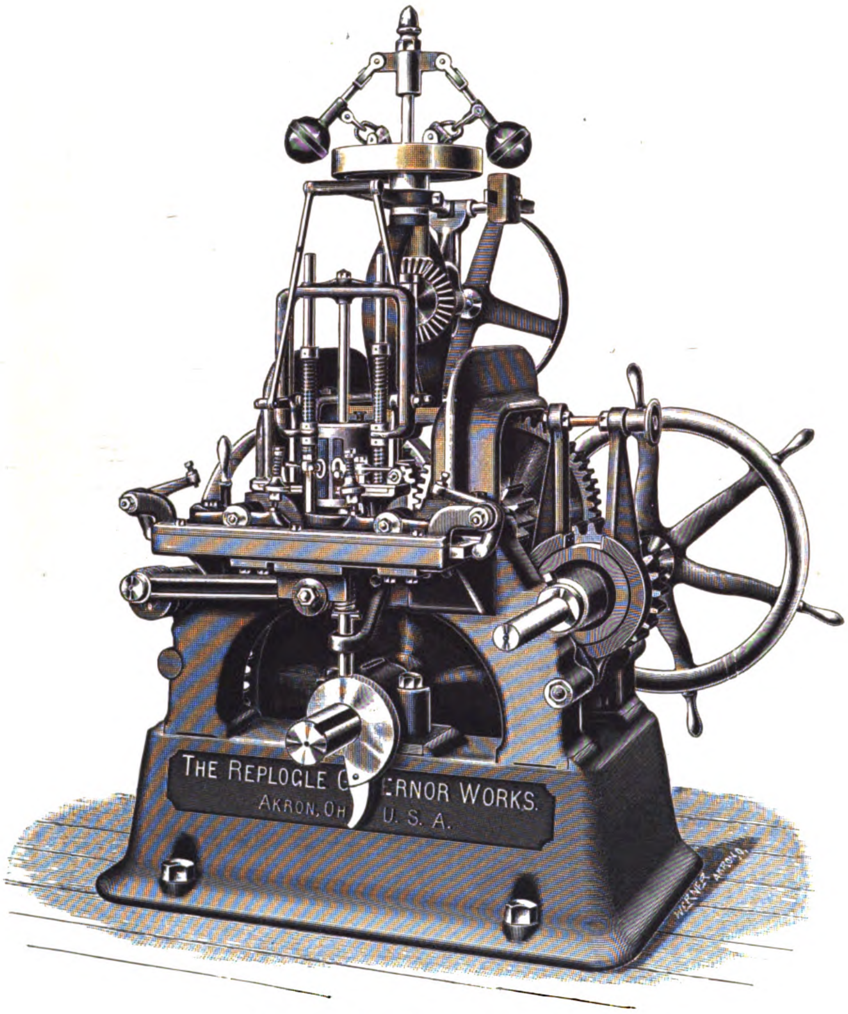

THE REPLOGLE G
ERNOR WORKS.
AKRON, OH
U. S. A.

FIG. 11.—TURBINE REGULATOR.

wires, 18 ins. apart, one phase on each side of the pole. The cross-arm is let into a gain, 1 in. deep, and held there by two 7 in. x ½ in. galvanized lag bolts, the bolt being screwed in—not driven. To further support the arm, a pair of galvanized iron braces, 1½ in. x ¼ in. x 19 in., are bolted to it by ⅜ in. bolts, and toed to pole with one 3 in. x ½ in. lag bolt. The gain for a second cross-arm was cut at the time of construction, to be utilized when the plant is extended.

One transposition is made in the line about one-half way between the power house and the point of distribution.

The insulators, which were furnished by R. Thomas & Sons Company, East Liverpool, O., are of the triple petticoat type, 5 ins. in diameter, 5 ins. high, and weigh 5 lbs. each. The glazed surface between the pin and the wire is 11½ ins. All were subjected to a break-down test of 40,000 volts.

A barbed wire, strapped and stapled to the peak of the pole, is run the entire length of the line, and grounded at the butt of a pole every half-mile.

Six feet below the transmission line is run a private telephone line, connecting the sub-stations and power house. This line, which has a transposition every half mile, is also arranged to connect with the local telephone system when desired. The drop in the transmission line is 10 per cent.

Fig. 8 shows the manner in which power and light are distributed. At present there are in sub-station No. 1—located about the centre of Delta—three step-down transformers. Two are of 35 k.w., converting from 5000 volts to 450 volts, one on each phase, and supply power to manufacturers by four No. 2 B. & S. soft-drawn copper wires, constituting the main power line. From these feed wires are led two motors, of a size depending upon the power supplied. The other transformer is of 40 k.w., converting from 5000 to 1200 volts, and supplying current to a switchboard, which is in the same station, for the Delta Electric Light Company, a separate corporation, under whose supervision the commercial and street lights are managed.

It will be noticed that the 40 k.w. transformer is attached to one phase only. The danger of overbalancing the system by so doing is governed at the terminal board on the generator.

From the sub-station switchboard two No. 8 B. & S. insulated wires are run to four transformers of 100 lights capacity each, converting from 1200 to 220 and 110 volts, and placed upon the poles at such positions as to feed the main lighting circuit evenly.

The town line consists of six wires, and is run on two cross-arms, one two-pin arm on top carrying the primary circuit, and a four-pin arm below, which carries the secondary circuit of three wires for commercial service, and one for the street lights. The street lights, as shown in Fig. 8, are connected on the outside wire and one leg of the three-wire system, thus being on a 220-volt circuit, which is run to the switchboard and there controlled by an automatic switch, which shuts off the current at midnight.

In sub-station No. 2 will be placed, at first, two 60 k.w. step-down transformers, converting from 5000 volts to 450 volts, which will furnish power to slate quarries, each of which will use a 30 k.w. machine for hoisting, cutting and dressing slate.

This plant to-day is working in first-class order, and will prove, in a short time a good investment to the owners, the Delta Power Company. As soon as 400 h.p. of the present installment are contracted for, it is the company's intention to duplicate the present machines.

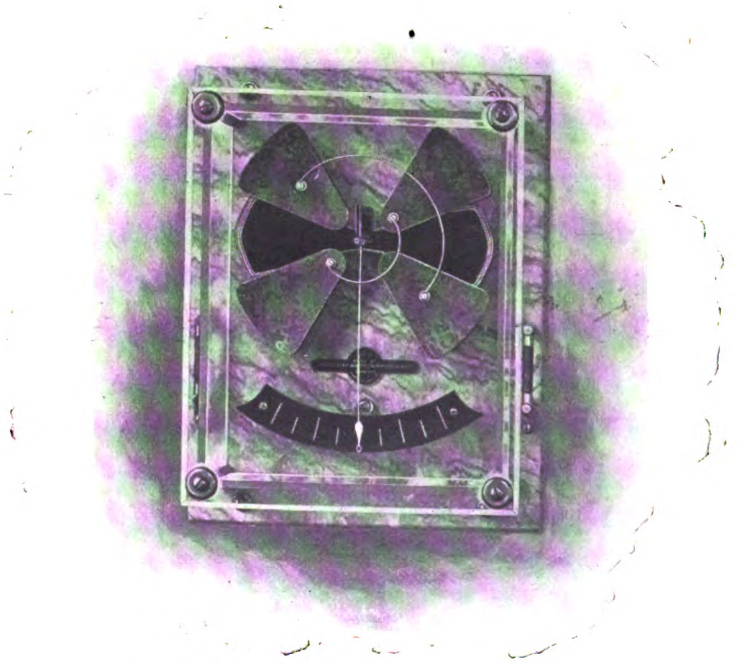


FIG. 12.—STATIC GROUND DETECTOR.

ARMATURE WINDINGS AND CONNECTIONS.

TWO LAYER AND MULTIPOLAR WINDINGS.

BY PROF. ARTHUR L. RICE.

In the first article were considered the conditions which must be fulfilled by a correct armature winding and the connections,

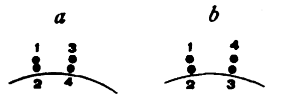


FIG. 1.—NUMBERING OF CONDUCTORS.

both lap and wave, for an armature with a single layer of wire. (It may be here noted that the caption of Fig. 7 should be "wave" instead of "lap" winding.) Few armatures are so made; it is generally necessary to use two layers of wire to get the E. M. F. required with a machine of reasonable size, and wire large enough to carry the current demanded. The process of connecting is the same, but requires some additional precautions.

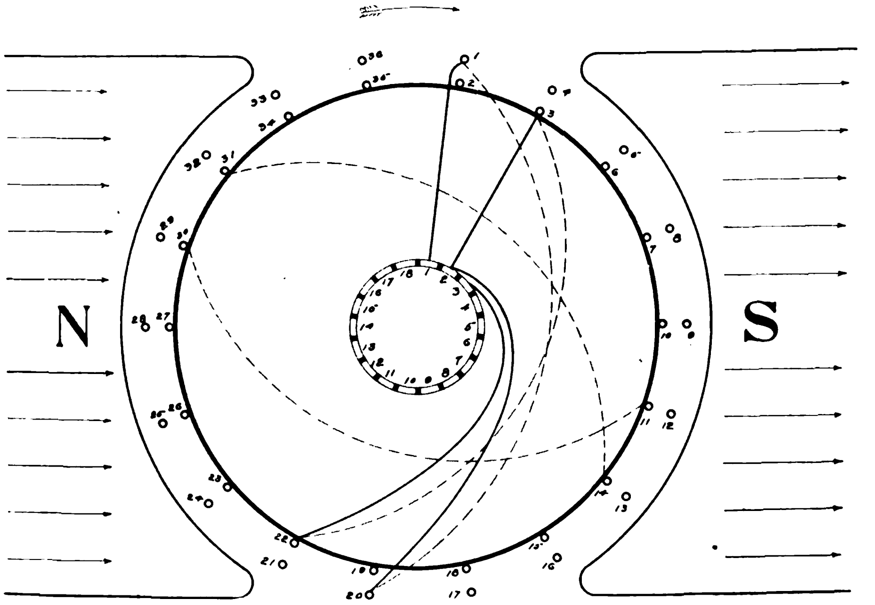


FIG. 2.—TWO-LAYER LAP WINDING.

Take the case of an armature for a dynamo having two layers of wire, 36 conductors, i. e., 18 coils and 18 commutator bars; the conductors will be placed two deep on the armature and standing opposite the bars. The winding may be on a smooth or a slotted core; in either case, the arrangement is the same. Either of the two methods of numbering, shown in Fig. 1, may be chosen. For the case under consideration it will be better to use (b), as the winding table is much more regular. It must be remembered that an inside conductor must connect on the back to an inside so as to make it possible to wind the coils, and the same for the outside conductors.

TABLE I.—LAP-WINDING CONNECTIONS.

Bar	1	to	conductor	1,	back,	to	20,	front.
"	2	"	"	3	"	"	22	"
"	3	"	"	5	"	"	24	"
"	4	"	"	7	"	"	26	"
"	5	"	"	9	"	"	28	"
"	6	"	"	11	"	"	30	"
"	7	"	"	13	"	"	32	"
"	8	"	"	15	"	"	34	"
"	9	"	"	17	"	"	36	"
"	10	"	"	19	"	"	2	"
"	11	"	"	21	"	"	4	"
"	12	"	"	23	"	"	6	"
"	13	"	"	25	"	"	8	"
"	14	"	"	27	"	"	10	"
"	15	"	"	29	"	"	12	"
"	16	"	"	31	"	"	14	"
"	17	"	"	33	"	"	16	"
"	18	"	"	35	"	"	18	"
"	1							

The winding to be considered is the lap form. Take a back pitch of 19 and a front pitch of 17, and suppose bar 1 to be connected to conductor 1, Fig. 2. Conductor 1 will connect to conductor 20, and both are outside conductors; the connection then goes to conductor 3 on the front. It would seem, at first sight, that the connections would be most symmetrical if conductor 20 is connected to bar 10; this would, however, give the full potential of the machine between bars 1 and 18, and is, therefore, unallowable. Conductor 3 is, therefore, connected to bar 2, and the connection from conductor 20 brought around by a long lead; the back connection is from 3 to 22, and so on, as given in Table I.

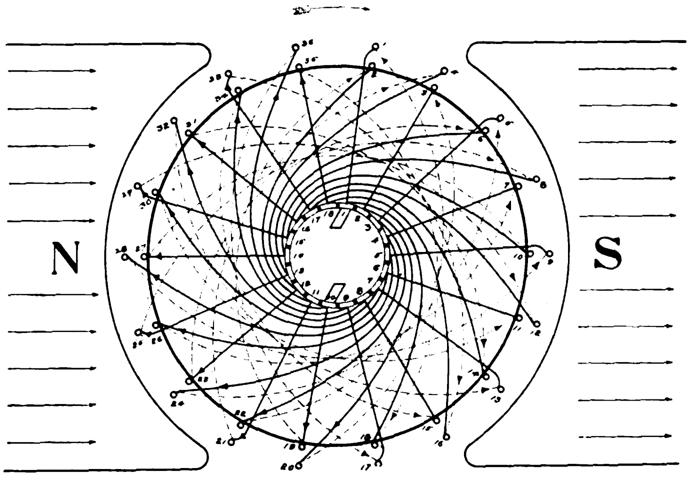


FIG. 3.—TWO-LAYER LAP WINDING.

The complete diagram is given in Fig. 3. By a consideration of the direction of current, as in the first article, it found that the brushes go on bars 1 and 10. This gives an equal number of conductors and coils by either path through the armature, and the two circuits will have the same E. M. F., because one of the two coils in the same slot is in one circuit, the other in the other. There is one objection; if Fig. 3 be inspected, it will be seen that the circuit leading from bar 1 through conductors 1, 20, 3, etc., has five outside coils and 4 inside; that leading through conductors 18, 35, 16, etc., has 4 outside coils and 5 inside. The former circuit will, therefore, have the greater resistance, but unless there be a great number of turns per coil, this will not be serious enough to need consideration.

In winding the armature, coil 3-22 should be wound first; next 2-19, next 14-31, and then 11-30 (the two latter being indicated).

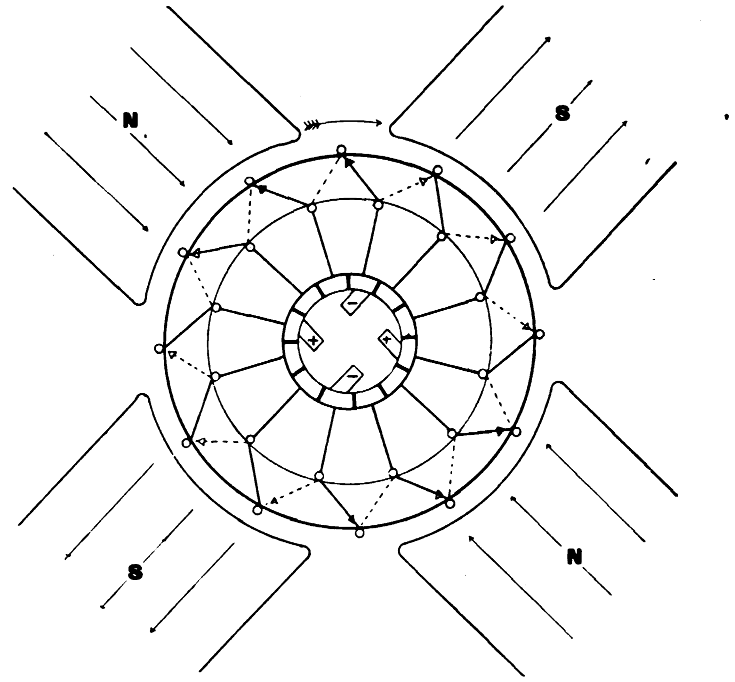


FIG. 4.—GRAMME RING FOUR-POLE WINDING.

then 11-30 (the two latter being indicated on Fig. 2), and so on, the back connections being carried on opposite sides of the shaft for successive coils, until all the inside coils are wound. Of the outside coils, 1-20 should go on first, next 4-21, next 12-29 and then 9-28, etc., until all the coils are in place. The long connecting leads should be soldered to the commutator first, and then the short ones. The object of winding and connecting in this order is to keep the same length of wire in each circuit, and to give mechanical symmetry and balance to the winding.

For a multipolar machine, the conditions which must be fulfilled are the same as for a bipolar. The Gramme ring form is the simplest in its connection. Consider Fig. 4; connections must be made, the same as in a two-pole machine, from the back end of one conductor to the front end of the one adjacent in order that the E. M. F.s generated may be joined in series. The inside conductors answer this purpose. If, however, the direction of the E. M. Fs. be traced out, it will be found that there are now four points instead of two where the currents from joined conductors tend to flow in opposition to each other; these points are nearly midway between the pole tips, as in the case of the bipolar machine; there will then be needed four brushes instead of two, and there will be four parallel paths for currents through the armature. Thus, a Gramme ring armature will answer for a two-pole or a four-pole machine without change, if the number of coils is divisible by four, the only condition being the addition of a second pair of brushes. Note that the positive brushes are opposite each other and the negative brushes the same, a positive being at 90 degrees from a negative. By analogy, a Gramme ring armature will run correctly in a machine with any number of poles, provided that the number of coils be divisible by the number of poles, and as many brushes be used as there are poles. The armature will also always have as many circuits in parallel as there are poles, and brushes of the same sign should be connected in parallel.

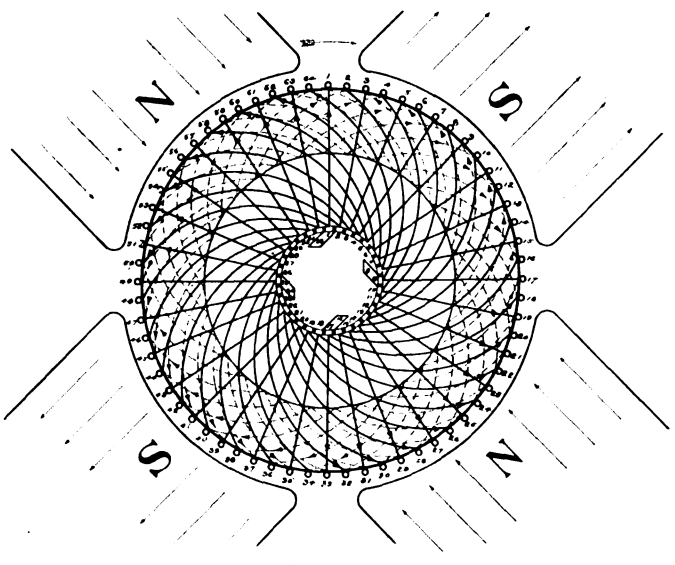


FIG. 5.—DRUM FOUR-POLE LAP WINDING.

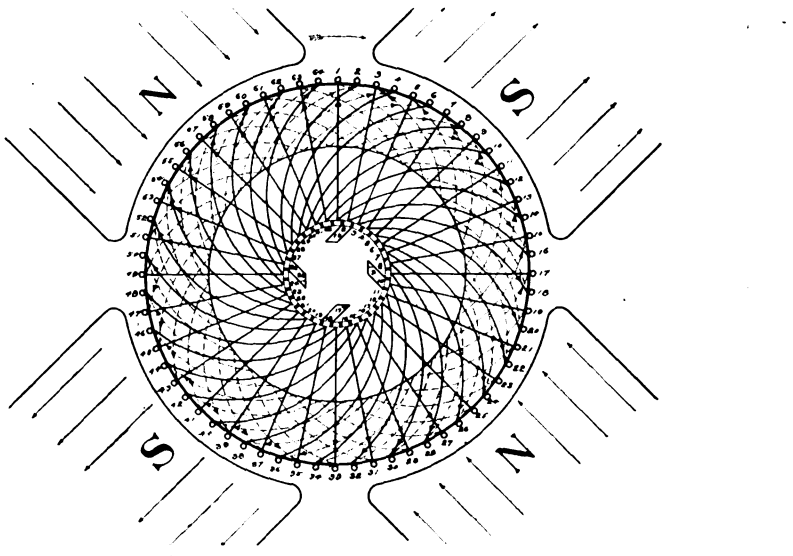


FIG. 6.—DRUM FOUR-POLE WAVE WINDING.

For a multipolar drum armature the end connections will be between conductors under poles of opposite sign, but not, as for a bipolar, at about 180 degrees apart. Take the case of a four-pole machine, to have 64 conductors in a single layer, the winding to be a lap connection and have a pitch of 15 back and 13 front; the odd number conductors being opposite the commutator bars, of which there are 32. Bar 1 will connect to conductor 1, thence to conductor 16, thence to bar 2, etc., Table II.

TABLE II.—MULTIPOLAR LAP-WINDING CONNECTIONS.

Bar		to conductor		back, to		front.
Bar	1	to conductor	1,	back, to	16,	front.
"	2	"	3	" "	18	"
"	3	"	5	" "	20	"
"	4	"	7	" "	22	"
"	5	"	9	" "	24	"
"	6	"	11	" "	26	"
"	7	"	13	" "	28	"
"	8	"	15	" "	30	"
"	9	"	17	" "	32	"
	Etc.					

The complete diagram is given in Fig. 5. On consideration of the direction of current, the brushes would be placed on bars 2, 10, 18 and 26; brushes on bars 2 and 18 would be connected, and also those on 10 and 26. There would then be four parallel paths through the armature, and one-fourth the conductors would be connected in series in each path. If the armature is to be cable wound, having but a single turn per coil, the odd number conductors would all be laid in place with the end of the coil extending to the rear; these ends would then be bent around and laid in place, as the even number conductors, and each end connected to its proper bar. If there are to be several turns per coil, the winding would best be made of "formed" coils, that is, coils wound on a form so as to cover the space between 1 and 16, and laid on in order.

A machine of this character would almost always be made a two-layer machine, and could be more easily wound either in cable or formed winding. If a wave winding had been desired, the pitch would have been 15 front and back, and the connections would have been from bar 1 to conductor 1, to conductor 16, to bar 16, to conductor 31, etc., as shown in Fig. 6. The placing of the brushes will now be on bars 1, 9, 17 and 25, on account of the change of direction of currrent in conductor 1, due to change of pitch. There is one peculiarity to be noticed: in the case of the lap winding, the commutator bars are connected in successively—in the order of their position; in the wave winding, an odd numbered bar is connected up, then an even numbered bar nearly opposite; next an odd numbered bar nearest the first one, and so on. This is a peculiarity that will be noticed in all multipolar, multiple-circuit wave windings.

It is possible, by some combination of front and back pitch, to wind up any number of conductors which is divisible by the number of poles into a lap-wound armature. For a wave-wound drum armature, the following relations must always exist:

$$\text{Number of conductors} \begin{matrix}\text{plus}\\ \text{or}\\ \text{minus}\end{matrix} \text{number of circuits} = \begin{matrix}\text{number of poles*}\\ \text{times pitch.}\end{matrix}$$

From this condition is determined the average pitch, when the number of conductors and the number of circuits is given. Thus, for Fig. 7, February number:

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* This may be expressed more briefly by the formula $C + K = ny$, where C = the number of conductors, n = the number of poles, y = the average pitch, K = the number of circuits in multiple.

$$24 + \text{or} - 2 = 2 \text{ times pitch.}$$
$$26 = 2 \times \text{pitch; pitch} = 13.$$
$$\text{or, } 22 = 2 \times \text{pitch; pitch} = 11.$$

In the case of Fig. 7, 11 was used. For Fig. 5,

$$64 + 4 = 4 \times \text{pitch}$$
$$\text{or } 64 - 4 = 4 \times \text{pitch,}$$
$$68 = 4 \times \text{pitch; pitch} = 17,$$
$$\text{or, } 60 = 4 \times \text{pitch; pitch} = 15,$$

and 15 was chosen.

The pitch thus determined is the average, and may be gotten by the use of any numbers for front and back pitch; thus, for Fig. 5, instead of using 15 front and back, 16 front and 14 back would have given an average of 15, and would have connected correctly.

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DESIGNING DYNAMOS AND MOTORS.

SMALL MOTORS.—II.

BY CECIL P. POOLE.

For the convenience of amateurs who are unaccustomed to such calculations as those presented in the preceding article, and who would, therefore, find the revision of the originally assumed figures burdensome, the writer has prepared tables showing economical fundamental measurements for motors of 1-16 to ½ h.p. to work on 110-volt, constant potential circuits. For machines to run on circuits of any other E. M. F. the slot measurements may require modification to suit the change in the size of armature wire, and in the case of very low voltages the length of the armature core may be reduced appreciably, because with larger wires the ratio of copper to insulation is much greater, and the slots contain a correspondingly large proportion of active material.

DATA FOR 110-VOLT MACHINES.

SERIES MOTORS.—DRUM ARMATURES. ARMATURE E. M. F. 55 VOLTS.

	Armature.								Field Magnet.				
			Core.		Slots.				Cores.		Yoke.		
H.P.	Amp.	Wire.	Dia.	Length	No.	Width.	Depth.	Rev.	Dia.	Length	Th'k's	Width	Bore.
1/16	1	No. 24	2	1½	8	0 4	0.4	3000	1⅜	3	¾	2	2⅛
1/10	1½	" 23	2	1¾	8	0.4	0.375	3000	1⅝	3¼	1	2	2⅛
1/8	2	" 22	2	2¼	8	0.4	0.4	3000	1¾	3½	1	2½	2⅛
⅛	2	" 22	2¼	2	10	0 4	0.3	3000	1⅞	4	1⅛	2⅝	2⅜
¼	3	" 21	2¼	2¼	10	0.375	0.3	3000	2 1/16	4	1⅛	2½	2⅜
¼	3	" 21	2½	2	12	0.375	0.3	3000	1⅞	4	1¼	2½	2 11/16

SHUNT MOTORS—DRUM ARMATURES.

H.P.	Amp.	Wire.	Core Dia.	Core Length	Slots No.	Slots Width.	Slots Depth.	Rev.	Cores Dia.	Cores Length	Yoke Th'k's	Yoke Width	Bore.
⅛	0 95	No. 24	2½	2	12	0.35	0.3	3000	2	5	1⅛	2⅝	2 11/16
⅙	1.25	" 23	2½	2½	12	0.35	0.3	2500	2⅜	6	1⅝	2⅞	2 11/16
¼	1.9	" 22	3¾	1½	18	0.46	0.3	1900	2 1/16	6	1⅝	2¾	3 15/16
½	3.8	" 20	3¾	2	18	0.46	0.3	1800	2 11/16	7	1⅞	3¼	3 15/16
½	3 8	" 20	3¾	2½	18	0 46	0.3	1450	3	7	2	3½	3 15/16
½	3.8	" 20	3⅞	2	24	17/32	17/32	1600	2⅝	6½	1¾	3⅛	4 1/16
½	3.8	" 20	3⅞	2½	24	17/32	9/32	1450	3	7	2	3½	4 1/16

This increase in economy with increase in wire sizes is shown plainly in the tables above mentioned. In the case of ¼ and ½ h.p. armatures with 18 slots, for example, the diameter of the cores being the same, the length of the ½ h.p. core is only one-third greater than that of the ¼ h.p. core, and the speed is lower, which would tend to increase the armature length. This is due to the fact that the core will only accommodate 40 per cent more of No. 22 wire than of No. 20.

The greater economy of material obtainable in low voltage machines may be illustrated by comparing the 110-volt motor described in the February issue of this paper, with a machine of the same dimensions wound for battery current. The diameter of the armature is 2 ins., the length 1½ ins., and the number of slots 8. The lines of force passing through the armature were figured to be 89,743, and if the counter e. m. f. of the armature be put at 6 volts the number of wires required will be

$$\frac{6 \times 10^8}{89{,}743 \times \frac{2000}{60}} = 134 -.$$

There being 8 slots, 16 wires may be wound in each, making the total number 128 instead of 134; the slots are 0.4 in. wide, and deducting the space occupied by insulating troughs, 0.35 in. remains for wire. Four wires, side by side, and four in depth give the required 16, and each wire must be not more than $\frac{0.35}{4} = 0.0875$ in. in diameter over the insulation; the nearest commercial size is No. 13, which measures 0.082 in. Four of these side by side measure 0.324 in., and with the slot insulation require a slot 0.375 in. wide instead of 0.4, as previously used; the depth also need be only 0.375 in. The resistance of the armature winding will be approximately 0.025 ohm, and the winding will pass 25 amperes easily; if worked up to that limit the drop in voltage will be ⅝ volt; including brushes and connections it may reach a volt, and this reduces the counter e. m. f. to 5 volts, and the requisite number of magnetic lines to 78,000.

Allowing a magnet core density of 78,000 lines and a leakage of 40 per cent, the area of the magnet cores will be

$$\frac{1.4 \times 78{,}000}{78{,}000} = 1.4 \text{ sq. ins.,}$$

or a diameter of 1 11-32 ins. This being a non-commercial size, 1⅜ ins. diameter will be better, giving an area of 1.48 sq. in., and density of 74,000 lines, scant. This was the size specified in the previous article, and the width of the yoke was 2 ins. For wrought iron the density in the yoke should be not over 60,000 to 65,000 lines. The flux through the yoke is usually from 5 to 15 per cent less than that through the cores, owing to the leakage at each end of each coil; the maximum flux being 109,200, that in the yoke will be about 98,000. A wrought iron yoke, at 65,000 density, would have a cross-section of

$$\frac{98{,}000}{65{,}000} = 1.507 + \text{ins.}$$

say 1½, or a thickness of ¾ in.

The length of the cores depends largely upon the C^2R loss in the field coils, as with constant potential at the terminals and a fixed size of wire and depth of winding, the exciting power of a coil is the same for any length within reasonable limits, the only effect of lengthening a coil being to reduce the heat loss. The length of cores for the 110-volt motor was 3 ins.

TABLE OF AMPERE-TURNS PER INCH OF LENGTH FOR VARIOUS MATERIALS AT DIFFERENT DENSITIES.

Lines per sq. cm.	Lines per sq. in.	Cast Iron	Cast Steel	Wr'ght Iron	Sheet Iron
2000	12 900	4	......	......	....
3000	19,350	7	......	......	1.5
4000	25,800	12	......	4	2 5
5000	32,250	22	......	5	3.2
6000	38,700	50	8	6	4.2
7000	45,150	85	9	7	5.2
8000	51,600	162	10	8	6.4
9000	58,050	......	12	10	8.1
10000	64,500	......	14	12	10.2
12000	77,400	......	20	19	17.5
13000	83,850	......	26	25	24.0
14000	90,300	......	38	36	32.0
15000	96,750	......	60	58	50.0

The densities, etc., in the various parts of the circuit may be summed up as follows.

	Density.	Total Length of Path.	Amp. turns.
Armature body	41,600	1.875 ins.	9
Armature teeth	97,000	0.75 "	38
Air-gap	$\frac{78\,000}{5 \text{ ins.}} = 15{,}600$	⅛ "	611
Pole-pieces (cast,	$\frac{97{,}000}{5 \text{ ins.}} = 19{,}400$	3 ins.	21
Field-cores	$\frac{109{,}200}{1.48} = 74{,}000$	6 "	102
Yoke (wrought)	$\frac{98\,000}{1.5} = 65{,}333$	3¾ "	45
Total ampere-turns			826

For shunt field windings the size of wire may be roughly approximated by the formula

$$\frac{At \times l}{v} = d^2,$$

in which At represents ampère turns; l the average length in inches of each turn; v the voltage across the terminals of the winding, and d^2 the size of wire in circular mils. Assuming a depth of ¼ in. for the winding, the average length of one turn is

$$(1\tfrac{3}{8} + \tfrac{1}{4})\,\pi = 5.1 \text{ in.}$$

the ampère turns being 826, and the voltage 6, the formula gives 702 as the value of d^2. The next larger size is No. 21 wire with 810 circ. mils. Seven layers of this give a depth of .2625 in., and each limb of the magnet will take 73 turns in length, giving a total number of turns of 1,022 and a total length of wire of

$$\frac{1022 \times 5.1}{12} = 434\tfrac{1}{3}$$

ft. on the cores, or 435 ft., including connections. The warm resistance of this will be about 6½ ohms, and the exciting current, therefore, not quite 0.925 ampère. This gives an almost absurdly high efficiency for such a small motor, the field current being less than 4 per cent of the total, if the maximum armature current be placed at 25 ampères. As battery energy is pretty expensive, however, it might be better to let the foregoing data remain unchanged in order to economize in battery expense, than to cut down the length of the cores and economize in material.

A comparison of this frame with the two windings will show the striking advantage presented by low-voltage machines. It should be remembered, however, that this advantage decreases as the size of the machine increases. For more just comparison, the machine described in the February issue will be considered as a 75-volt motor, with the dead resistance eliminated.

	6-VOLT MOTOR.	75 VOLT MOTOR.
Watts applied at terminals	155.56	75.
Watts wasted by copper losses	21.2	13.
Watts wasted by iron losses	0.76	0.76
Watts available for work and friction	134.4	61.24
Electrical and magnetic efficiency	86 per cent.	81.6 per cent.

It will be seen that the 6-volt motor is more than twice as powerful as the 75-volt motor, and a little more efficient, although the mechanical dimensions are identical.

In the previous article, referred to several times above, a number of confusing typographical errors occurred. The sentence beginning on the fifteenth line from the bottom of the second column should have read: "The iron loss would not exceed .0625 watt, making less than 1 watt for the entire core, or 1.36 per cent of the output," etc. The hysteresis loss in the teeth was given at 9 watts per cubic inch instead of .9 watt, and the length of armature referred to as 6.36 ins. instead of 1½.

Another error, due to hasty copying from original data by the writer, was a reference to the total flux of lines through the armature as 77,000 instead of 89,743.

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ELECTRIC RAILWAY FEEDERS.

BY GEORGE T. HANCHETT.

Heavy electric railroading over private rights of way has brought the third rail into prominence, and the problem of distributing current by means of suitably insulated rails bonded together has become a serious one, for it has been demonstrated that the cost of a steel feeder made after this fashion is about one-third that of an equivalent copper cable. In calculating such steel feeders the engineer will turn to his tables of relative conductivity and will devise a method for estimating their resistance, but as such calculations have not been extensively made, there have been devised no easy and conveniently remembered formulas for making such calculations of which the writer is aware. Therefore a few suggestions along this line may not be unwelcome.

There are two numbers which, if remembered, will wonderfully assist in the calculations of steel feeders. These are 55 and 58, both multiples of 11. Rails are usually designated by their weight in pounds per yard, and therefore it is convenient to refer everything to this as a starting premise, for that is all of electrical interest that the engineer usually knows about the rail he proposes to use. Let, *w*, represent this weight in pounds per yard, then it follows that the weight in tons per mile of a rail of weight, *w*, per yard, is $5280 \times w \div 3 \times 2000$, which is equal to .88, *w*.

Rails are now supplied in 60-ft. lengths, and such rails are almost always used for third rail systems for the reason that they divide the number of bonds required by two. There are 88 rails, and therefore 88 bonds to the mile. The accompanying table will assist in estimating for ordinary purposes the cost of bonding:

SIZE AND COST OF COPPER BONDS.

Weight of Rail, Pounds per Yard.	Equivalent Copper Bond Circular Mils.	Cost of Equivalent Bond.
5	90909	$.39
10	181800	.59
15	272700	.83
20	363600	1.04
25	454500	1.27
30	545400	1.51
35	636300	1.73
40	72/200	1.97
45	818100	2.20
50	910000	2.43
55	1000000	2.65
60	1091000	2.88
65	1182000	3.12
70	1275000	3.36
75	1364000	3.59
80	1455000	3.82
85	1546000	4.05
90	1637000	4.28
95	1727000	4.54
100	1819000	4.79
105	1909000	4.92
110	2000000	5.19

Rails are seldom bonded to their full carrying capacity, though when used for feeders there is no reason why this should not be. In using this table we may take, for instance, a 60-lb. rail, and if we desired to bond it for ¼ of its carrying capacity, we would use a bond equivalent to a 15-lb. rail, or one of 272,700 circular mils, and similarly in other cases.

Eighty-eight, which has twice occurred in the foregoing, may be considered as the mechanical constant in calculating feeders, for it relates entirely to weights and numbers; 55 is the electrical one, and by properly incorporating into it the calculations, we may calculate the circular milage of an equivalent copper cable and the resistance of a rail per foot. A 55-lb. rail is electrically equivalent to one million circular mils. Therefore, if we have a rail of weight, *w*, and divide this weight by 55, multiplying the result by one million will give the equivalent copper cable for that rail. Those who are fond of their own formulas can, therefore, calculate their copper cable in the usual way, dividing the resulting circular milage by one million and multiplying the quotient by 55, thus obtaining the weight of rail in pounds per yard which will replace the copper cable.

For those who prefer to calculate the resistance of the rail directly, the following is convenient. If we divide .00055 by the weight of the rail in pounds per yard, we shall have its resistance in ohms per foot; and conversely, if we have the resistance of the required feeder in ohms per foot, we may divide that into .00055 and get the necessary rail in pounds per yard.

From the foregoing it is easy to see that a foot of rail will carry an amperage equal to one hundred thousand times its weight per yard, with a drop of 55 volts, and if we divide this current by the number of feet the rail is to transmit, we shall have the current the rail can carry for that distance at a drop of 55 volts. Inasmuch as 50 or 55 volts is a common line loss on heavy railroad systems, this formula is quite convenient; and the converse is equally so, consisting merely of a case where we have a given number of feet and a specified 55-volt drop, and a given rail and desire to know the number of amperes that can be successfully transmitted under those conditions. Obviously, we simply divide one hundred thousand times the weight of the rail by the distance in feet. This formula cannot be applied to return feeders consisting of the service rails. It should be remembered, however, that there are four times as many bonds in a set of return service rails, which are usually 30-ft. lengths, than in the outgoing feeder rails. A few examples will better illustrate the application of the foregoing formulas:

Suppose we are to transmit 2000 amperes a distance of 1000 yards, and that we have a 60-lb. rail for the purpose, what will the drop be? Dividing .00055 by 60 we at once get the resistance per foot. If we multiply that by the number of feet in the line, 3000, we get the entire resistance of the line, and if we multiply that by the current to be transmitted we get the drop. Therefore,

$$\frac{.00055 \times 3000 \times 2000}{60} = 55 \text{ volts.}$$

The converse of the problem is even easier. Suppose we have a 60-lb. rail, how much current will it transmit 1000 yards at 55 volts drop? Applying our formula, we multiply 60, the weight of the rail, by 100,000 and divide by the distance in feet, when we get

$$\frac{60 \times 100000}{3000} = 2000 \text{ amperes.}$$

Again, suppose that we have calculated a line and find that its resistance per foot must equal .000009167 ohms, what weight of rail will fill these conditions? Following our formula, we divide the resistance per foot into the quantity .00055, whence we get

$$\frac{.00055}{.000009167} = 60, \text{ nearly.}$$

If we have a rail weighing 60 lbs. to the yard and wish to find the equivalent cable, or the size of a copper bond which will have equal conductivity per unit of length, we divide 55 into the weight of the rail and multiply by 100,000, which gives the following:

$$\frac{60 \times 100000}{55} = 1091000 \text{ circular mils;}$$

and vice versa, if we have calculated by ordinary methods, that a cable of 1,091,000 circular mils is necessary to transmit a certain amount of power, we point off six places and multiply the result by 55, which gives us

$$1.091000 \times 55 = 60, \text{ nearly,}$$

the weight of the equivalent steel rail.

Lastly, if we wish to determine the weight of a 60-lb. rail in tons per mile, we multipy by .88, which gives us

$$60 \times .88 = 52.8 \text{ tons.}$$

These formulas are based on the follow-

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ing facts: First, that a 55-lb. rail is equivalent to 1,000,000 circular mils, and second, that a foot mil of copper has a resistance of 10 ohms. Neither of these assumptions is absolutely accurate; 10 ohms is high for a foot mile of pure copper, but is more accurate where commercial copper is considered than the value given for pure metal. Steel rails, it is to be added, are apt to vary considerably in their resistance. According to the formula, the ratio of the section of the steel and copper feeders of equal conductivity is nearer 7 than 6, but it has been stated by some that steel rails have run as high as 12 times the resistance of copper feeders of equal section. For this reason it is very advisable in ordering steel rails for electric railway purposes to test samples, because their electrical resistance in such cases is almost if not fully as important as their mechanical qualities.

STORAGE BATTERIES IN ISOLATED ELECTRIC PLANTS.

BY CHAS. BLIZARD.

The advantages of accumulators as auxiliaries in central and power stations are now so well recognized as to require no comment. The service that a battery can perform in connection with an isolated lighting plant is no less valuable, and the following may be pointed out as some of its applications in this capacity.

A battery of accumulators, operated as an auxiliary to an isolated electric plant, will assist the dynamo during the hours of heavy load, and also in the case of sudden momentary overloads. It will permit of the operation of a smaller generator than could otherwise be used.

By the addition of a battery to an existing dynamo plant the total capacity of the plant may be increased without enlarging the generators; the battery charged during the hours of light load will assist the dynamo in meeting the demands during the periods of heavy load. In this system the dynamo is run under a practically full, steady load, and at its most economical point.

A battery will furnish current for the night service or during the hours of the day when the load is too light for the economical operation of the dynamo. In this service it will generally effect a very marked saving in the fuel and labor accounts; in the former by running the engine at its most efficient point, and in the latter by dispensing with one or two shifts of men.

A battery will act as a regulator of potential, permitting lighting and electric elevator services to be taken from one generator, which is run at full, steady load, while without the battery two generators are required, one of which, at least, is run under a widely fluctuating and very uneconomical load.

A battery increases the reliability of the service, as by protecting the generator and engine from the strains of sudden overloads it removes a fruitful cause of breakdowns. In case of a temporary stoppage of the generator, a battery may be discharged at a very high rate and will carry the entire load up to the limit of its capacity.

By the use of a battery a 24-hour electric service may be obtained, with but a day run of the generating plant, and a battery will also furnish the current required during Sundays and holidays.

The only expense connected with the operation of a battery in an isolated plant is the maintenance and the interest on the first cost. Any intelligent man who will follow instructions can take proper care of a battery, and the attention required is so limited that no increase in the engine room force is necessary.

In office buildings, apartment houses, hotels and buildings of a similar class operating electric elevators, a battery will act as a regulator during the day, permitting the power for the lamps and elevators to be taken from one dynamo; it will assist the dynamo during periods of heavy load; it will furnish the current required by lamps and elevators during the night and over Sundays and holidays. If it be included in the original installation the capacity of the generators may be reduced and the first cost of the entire plant, with or without the battery, will be practically the same.

Batteries operated in the service outlined above are showing an annual net saving of from 25 per cent to 40 per cent on their cost.

In office buildings, mills, factories and hospitals and other similar institutions without electric elevators and a night lighting service, a battery charged during the day, with the surplus current from the dynamo, will assist the generator during the heavy loads and will furnish currrent for the lamps required after the dynamo has been shut down, saving all expense for gas or street current.

Batteries operated under these conditions are effecting a saving on their cost of from 20 per cent to 35 per cent per annum.

In residences a battery is an essential part of the electric plant. By a few hours' run of the dynamo to charge the battery, current for lamps, fan motors, etc., may be had at all hours of the day and night.

If operated in connection with a gas or gasoline engine, a battery will act as a regulator, producing an absolutely steady light.

INCANDESCENT LAMP FILAMENTS.

BY JNO. C. SHEDD, M. S.

The main elements that enter into the success or failure of the incandescent lamp are three. First and foremost stands the filament; second, the securing of a good vacuum, and third, the leading-in wires.

In the earlier lamps the first factor was chiefly considered and thousands of dollars were spent in trying to discover a substance that would neither oxidize in air, nor melt at the high temperature of incandescence. It being found that all substances that conduct electricity also oxidize, the vacuum pump was resorted to, to remove the air, and thus the first difficulty was surmounted. The second requirement was not so soon secured, and for a time platinum seemed to be the only available material.

It was very soon learned by experience, however, that platinum could not be depended upon to withstand the high temperature of incandescence, but that it inevitably fused at the critical moment.

In the meantime many other substances were experimented upon, and success was met in another direction with material both plentiful and cheap.

It had long been known that carbon was infusible at the highest temperatures, and that it possessed the requisitely high resistance. Indeed, some of the earliest experimental lamps had filaments of this material. The difficulty in the way of its use was twofold. First, the lack of a cheap and rapid method of manufacture, and second, the fact that while carbon is infusible, it is very rapidly oxidized when brought to a high temperature in the presence of even a trace of oxygen.

The latter of these difficulties may be met in either of two ways, first by means of the vacuum pump which is designed to remove all air; or second, by the introduction of a so-called inert atmosphere. The latter method presents the advantage of being the easier, as it is only necessary to displace the air in the globe by nitrogen or CO_2, or other gas that will not act chemically upon the filament. This method had its short-lived day, and now the vacuum method is alone used, for reasons independent of the chemical action. The presence of the gas is detrimental in that it absorbs the light and, what is more serious, produces convection currents which carry the heat from the filament to the glass. This can be observed even by the hand, for the globe of such a lamp is hotter than that of a vacuum lamp.

The early methods of carbon filament manufacture were cumbersome and unsatisfactory, producing a heavy filament, that had to be used at low voltage or else with several in series. The Edison bamboo filament was perhaps the first that was a commercial success. In this the fibre from the inside of the bamboo cane is taken and dressed into a round straw three or four inches long. These strips are then bent into a loop as they appear in the lamp, and are closely packed with powdered charcoal in iron retorts. The retorts are placed in a furnace and brought to a red heat. The result of this firing is to drive out all the chemical constituents of the filaments save the carbon, which is saved from oxidation by the charcoal packing. When removed they present a dark porous structure relatively strong and of high resistance.

The earlier lamps were supplied with filaments of this type, but they were frequently found not to be of uniform section throughout, and hence of greater resistance at these points. The result was that the points of smaller section rose to a higher temperature, thus endangering the life of the filament.

The remedy for this defect was soon found and is very ingenious. The filaments are placed in air-tight receptacles, which are then filled with one of the lighter of the hydrocarbon gases—such as that from gasoline—and the current is turned on the filament. The gas is now decomposed by the heat, the hydrogen being set free and the carbon deposited upon the filament. This deposit takes place most rapidly when the temperature is highest, so that the points of least section are built up the most rapidly, until finally the filament presents a uniform appearance throughout. This process of treating, or flashing, as it is called, also changes the color from a dead black to a steel gray.

Another material much used in filament making is cotton; which is first spun into a cord of a size determined upon by experiment and is then treated to a bath of sulphuric acid in water, which obliterates all structure, and renders it homogeneous throughout. Proper lengths are then cut off, laid in the proper loop, dried and fired. The resulting filament is not porous like the bamboo, and requires less flashing. The bamboo filament may now be considered as of the past, having been displaced by various secret formulæ used in the preparation of cotton or squirted filaments. The difference in color between the treated and untreated filament also involves a difference in their optical properties, the lighter colored surface being considered the better radiator. This advantage, however, is frequently offset by a deficiency in the vacuum, which is a factor frequently overlooked in considering incandescent lamps.

We have now secured a durable filament in a vacuum. The third requirement, while of minor consideration, is still essential. Its importance lies in the fact that when the lamp is burning, the glass globe of necessity expands with the rise of temperature, and again contracts when cooled. Were it possible to have an all-glass envelope, the matter could be dismissed, but since the filament must be in metallic connection with the base of the lamp it is necessary to take into account the expansion of the leading-in wires. The requirement to be fulfilled is that they shall have the same co-efficient of expansion as the glass; for, suppose the wires to have the larger co-efficient, it is evident that as the temperature rose they would expand more than the glass and break it; on the other hand, were the reverse the case the glass would expand away from the wire and cause a leak.

The substance that is found to agree most nearly with glass in this respect is platinum, and it is a significant fact that it was this feature of the Edison patent that alone withstood the efforts of infringing companies. Another variation from the usual all-glass envelope was the so-called stopper lamp, devised partly to avoid patents, and partly to facilitate the replacing of broken filaments. In this lamp the base, supporting the filament, is joined to the globe by a ground-glass joint, which is also cemented to render it air-tight. This feature, while in itself commendable, is nevertheless probably as expensive as the globe whose life it saves.

Having thus solved the main problem in connection with the incandescent lamp, the attention of the manufacturing companies is now turned to the details of construction. Thus, it is found that the air clings to the sides of the globes, so that it is by no means easy to get a satisfactory vacuum in a short time. The filaments also show a tendency to distintegrate with age, and to throw a cloud onto the globe, thus seriously reducing the candle power. This aging is also accompanied by a rise in the resistance of the filament, still further reducing the candle power when the voltage remains constant.

One company has even taken up the question of the shape of the filament, and has adopted one of square section, claiming that the added radiating surface raises the efficiency of the lamp. The argument is as follows: The current-carrying capacity of the filament depends upon the cross section, while the candle power depends, in a measure, upon the amount of radiating surface. If two filaments be taken, one with a circular, and the other with a square section, but of equal area and equal length, both will carry the same current, but the square filament will have the larger surface in the ratio of 100 : 86. Whether this advantage is important, careful experiment can alone decide.

ELECTRICITY.*

BY W. D. WEAVER.

Electricity is popularly considered the transcendent mystery among the forces of nature—a mystery which has defied all the powers of science, and the lack of a solution to which is a reproach to the human intellect. Moreover, it is generally believed that marvelous developments await the reply to the question, What is electricity?

This view is entirely unjustified. We know no more of heat, light and gravity than we do of electricity, yet lack of knowledge with respect to these gives rise to no lamentations, and startling discoveries are not confidently anticipated in the near future which will revolutionize the sciences of thermodynamics, optics and mechanics.

In point of fact, gravity, the most familiar of the forces of nature, is the one of which we know the least. Why does a stone when dropped from the hand seek the earth? To say that it is attracted by the mass of the earth merely involves reasoning in a circle, and gives no clue to the mechanism whereby it is constrained to take a course toward the centre of the earth. Of this mechanism, unlike that of electrical action, we have no satisfactory explanation; but, nevertheless, we never hear of a contractor hesitating to invest in a pile-driver for fear that at any moment some new discovery concerning gravity may result in the production of pile-drivers immensely superior to those in present use.

On the other hand, the theory of electrical action—based upon the work of Faraday, developed by Maxwell, Helmholtz and Kelvin, and experimentally demonstrated by Hertz—is as firmly established as are the theories of light and heat, with which it is, indeed, identical. This theory, however, may well be left to the savants—first, because its proper understanding requires a comprehensive knowledge of mathematics and years of study; and second, because its perfect understanding would not enable one to add a single watt to the output of any of the electrical apparatus now in commercial use.

The popular cry for a solution to the great mystery of electricity usually arises from the misconception that electricity is a substance—a "juice"—while in reality it is a mere word representing nothing definite, corresponding, in fact, to the algebraic *x*. As in the case of heat and light, we know certain effects and, following the human instinct, we are impelled to assign a direct cause, even though this consists of but the use of a name. All that we really do know is that we can transform into what we call electrical energy several other forms of energy known as mechanical energy, heat, and chemical or molecular energy. As electricity, so-called, can only be known to us from its effects, and is only useful to us as a form of energy, the mechanism of the transformation is really a matter of indifference so far as practical working is concerned, though, of course, of interest to other than savants in the same manner that it would be of interest to know the daily habits of the people of Mars, should that planet be inhabited.

In the dynamo, mechanical energy is transformed into electrical energy at an efficiency attaining 95 per cent. and over in large machines. We know the exact nature of all the losses accounting for the small deficit between 95 per cent and perfect efficiency, and know that none of these could be nullified were a complete answer given to the question, What is electricity?

A primary battery transforms into electrical energy as high as 50 per cent or more of the chemical energy supplied to it, and the nature of the wastes, as in the case of the dynamo, are known and their amount accounts for the difference.

Processes for the transformation of thermal into electrical energy by means of thermo-piles, thermo-electric batteries, magnetic heat engines, etc., or other similar processes that may in the future be discovered, are no less thoroughly understood so far as principles affecting efficiency enter, and higher efficiencies would not be obtained by any additions of knowledge concerning the electrical mechanism of the respective transformations involved.

In other words, with one exception to be noted later, in order that electricity may be produced at less cost than by present means, the discovery is necessary of a new form of energy whose transformation into electrical energy will be commercially effected more cheaply than by present methods. The discovery of such a new form of energy, however, is a matter no more related to the electrical than to any other branch of science. It may be added that electrical energy is the only entirely new form of energy with which man has become acquainted within historic times—though Mr. Keeley might dispute this assertion.

The exception above noted relates to the direct conversion into electrical energy of the energy set free by the oxidation of carbon. When carbon unites with oxygen, a definite quantity of energy becomes available for transformation into other kinds of energy. At present such transformation cannot be made direct into electrical energy, the state of heat having first to be passed through, and this involves a great loss, owing to the action of a law of nature known as the second law of thermodynamics. The problem of "Electricity Direct from Carbon" is, in fact, the most important now presented in electrical science.

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"Light Without Heat" is another problem to which it has been thought electricity might furnish a solution, but thus far the work done in this direction has been without practical result. The effect of light is produced by vibrations in the ether of a frequency expressed in numbers by multiplying 5 by the 14th power of 10. It has been hoped that the ether might be "whipped up" to this frequency by electrical means, but three formidable difficulties have interposed.

In the first place, the frequency that may be obtained in the direct transformation of mechanical into electrical energy is limited; for example, a generator with 1,000 poles running at 10,000 revolutions per minute would generate a current of less than 100,000 periods per second. Secondly, with very high frequencies electrical energy cannot be transmitted by means of wires, owing to the increase in the apparent resistance of conductors at high frequencies. A No. 0 conductor, for instance, at a frequency of 100,000 periods per second would act as if its resistance were increased more than ten times, and with a frequency in the millions would become practically a non-conductor. Finally, in the only method known of obtaining very high frequencies, which is by means of the disruptive discharge, the losses are very great, a large part of the energy being dissipated in heat. The smallest electrical wave length that has been obtained even by the latter method is eight inches, corresponding to a frequency exceeding two billion periods per second—a frequency, however, more than 200,000 times less than that of light. The above considerations give an indication of the difficulty—if not the hopelessness—of the commercial problem of producing light by electrical means except through the intermediary of heat, either directly, as in the arc and incandescent lamp, or by molecular impact, as in the vacuum tube.

Recently the subject of the transmission of electrical energy without wires has been brought forward in a practical manner in the Marconi telegraph. This application is of peculiar interest, as it confronts us with the identity of electricity, heat and light. A source of heat or light sets up vibrations in the ether, which are propagated through space and give up their energy, in whole or in part, when something responsive is encountered—the eye, for example, in the case of light, or a thermal absorbent, such as a black surface, in the case of heat. Similarly, an electric discharge disturbs the ether, setting up vibrations in it which produce an electrical or magnetic effect when the waves encounter a responsive object—this object, in the case under consideration, being a very special arrangement known as the "Branly tube." The only difference between the several vibrations above mentioned is in the length of the ether wave, which is least for light, intermediate for heat, and longest for electricity.

In the Marconi system, an electrical discharge between the knobs of an induction coil sets up a disturbance in the ether, the discharge of the coil being controlled by an ordinary telegraphic key. This disturbance is transmitted through space in the form of ether waves, which, upon striking a certain powder normally nonconductive, causes it to become conductive, thereby closing a local circuit through the tube in which the powder is contained. In circuit with the tube is a battery and a telegraphic receiving instrument, and every time the sending key actuates the induction coil, the local circuit at the receiving end becomes conductive, thereby permitting a flow of current from the battery to operate the receiver, which latter registers or sounds a signal corresponding to that made with the key at the transmitting end.

As will be seen, the vibrational energy absorbed by the tube must be infinitesimal in amount, as the powder can have but very little work performed upon it. Nevertheless, is there not a probability that electrical energy for power purposes may in the future be transmitted by this process?

The answer to this question cannot be favorable. To start with, we must first transform, as at present, some form of energy, such as mechanical energy, into electrical energy. Next, the electrical energy must be transformed into a particular kind of ether vibrational energy. Finally, a receiver must be invented that will respond to the ether waves sent through space, and transform their energy into useful work. That is, we would have a generator at one end and a motor at the other, as at present; in addition, there would be a secondary transforming apparatus, against which, however, would be balanced the gain from utilizing the ether of space instead of metallic conductors in the transmission. Aside from the loss in the secondary transforming apparatus—and in such devices at present known the loss is great, much of the electrical energy being wasted in heat—we are confronted with the question, Can the vibrations thus set up be so directed that all the energy imparted to the ether will be utilized at the receiver? As ordinarily generated, the waves would radiate in every direction, and while such waves may be reflected and refracted like heat and light waves, and thus may be gathered into a beam, to do so would entail a loss, even were it at all practicable, which is extremely doubtful.

To resume, electricity is but a name, and electrical energy is alone a reality. The mechanism by which one form of energy is transformed into another—that is, the nature of electrical action in the present case—is to us a matter of commercial indifference so long as a knowledge of it will not result in increasing the efficiency of transformation. Finally, the only direction from which at present there appears any definite promise of increasing the efficiency of any of the several kinds of electrical transformation, is from the oxidation of carbon without heat—a problem which, it may be added, is now occupying the attention of the great electro-chemists of the world.

BLINDESS FROM THE ELECTIC ARC.

BY PROF. ARTHUR J. ROWLAND.

The danger to one's sight from the light of an electric arc, no matter whether produced for a useful purpose, or the result of some chance short circuit, should be clearly understood by every one. This is especially true, in view of the many uses of electric arcs, besides those so familiar in the common 1200 and 2000 candle power arc lamps.

If one's line of vision takes in such an arc as that in the ordinary arc lamp, or that due to an accidental short circuit, or one at the break of a large current at high potential, the eyes suffer a sort of paralysis, and on looking away one sees as through a fog. This effect soon passes away, and at worst requires a sojourn of a day or two in a dark room to produce a cure.

With arcs taking large currents, and especially if one electrode is metal, the effects are quite different and much more serious. At night one notices the intense brilliance and is on his guard. In daylight the contrast is not so great, and so one is more likely to suffer because of lack of care. After working with such arcs the eye does not immediately feel the effect; but after a time, perhaps hours afterward, a slight scratching is felt in the eye, as though there were some fine dust or cinders there. As time goes on this is followed by a feeling of dryness on the eyeball, accompanied by a very profuse shedding of tears, and all the symptoms of a heavy cold in the head are felt. If the attack is a bad one, the pain becomes a very intense aching and may be accompanied by a twitching of the eyelids. In these worse attacks the afflicted one can bear no light on the eyeball, and if the eyes are opened finds he is blinded.

In case of slight attack a simple eyewash is all that is necessary for a cure. Use one made of six grains of borax in a fluid ounce of infusion of sassafras pith, or one of ten grains of boric acid in an ounce of camphor water. I can vouch for the first and have almost equal confidence in the second. In a very bad case a physician will apply cocaine, that local anæsthetic so commonly used in the eye. No one but a physician should do this.

After a few hours the pain passes away, and by keeping in a darkened room and then wearing smoked glasses for a couple of days, the eye wash being kept in use, all ill effects pass away, leaving the patient with a firm resolve to avoid further experience in this direction.

It is found that the effect of the arc has been to produce an external burn—like a sunburn—on the conjunctiva, or outer membrane covering the front of the eyeball. If one protects the eyes, this "sunburn" from the arc affects the skin; and results precisely like those after a day's out-ing at the seashore in midsummer are experienced.

In protecting the eyes against the burning power of such arcs it is not sufficient to simply wear such glasses as are made for those who adjust and repair common arc lights. Far too much of the light gets around them. It is necessary to use a mask covering the whole face. Even if one thinks to protects himself from all direct rays, by holding his hand before his eyes for example, there will still be likelihood of his suffering to some extent. In this way one who stops to look on may suffer from an eye trouble, the cause for which he has quite overlooked.

Drexel Institute, Philadelphia.

Electrical Inspection.

To the Editor of American Electrician:

I have read with much interest what you say in the February issue about municipal inspection boards and their advisability.

If the inspection department of all boards of underwriters were conducted on the plan of the New Hampshire board, municipal boards would not only be advisable but an actual necessity if proper protection against fire hazards is to be obtained.

This State has been for two months without any inspector whatever, while during that time building has been progressing rapidly and house after house has been wired, the reports sent in, and no inspection has taken place on any of the buildings.

The buildings which are put up in this city are usually of a fire-trap order, in that they are cheaply constructed, of wood mostly, and all wiring is lathed in, the plastering is on, and in nearly all cases the house finished and connections made by the electric light company before the inspector gets around to examine the building. What he can at that time discover in regard to faulty electrical construction may be easily surmised.

A case recently came to my knowledge in a town not a dozen miles from this city where a church, wired five years ago and lighted during that entire period, was never inspected until some time during the past summer, when the society owning the same erected a parsonage on the adjoining lot.

Inspection was requested on the wiring of the parsonage, and shortly after the contractor received a bill of complaint, with instructions to immediately fix up the faulty work on the church, wired five years before by another firm.

With sharp competition, unprincipled contractors and careless workmen, a premium is placed on "sloppy" work, to say nothing about dangerous wiring, by this method of State inspection.

I went into a house not long ago which had been wired and was in process of lathing, and found ten or twelve unsoldered bare joints, at least half of which had been lathed in and the rest would shortly have been. That is only one instance, of which there are many. It seems as if the underwriters should embody in their rules one forbidding the covering up in any way the wiring until the same had the approval of the inspectors, and positively refuse any risks where this rule was violated. In the larger cities, where municipal inspectors are employed and buildings are constructed on a fire-proof plan, such annoyances may not be common, but in a city of the size of Manchester it is a common occurrence.

In many a case I have seen a gang of lathers following the wiremen and covering up the wires before the electrician had time to leave the room to go to another. In many other cases the plumbers, gas and steam fitters have laid their pipes upon and across the wires, and frequently I have heard the remark from them "that won't do any harm; they are only electric light wires, and will be covered up before the inspector sees it."

With a municipal system of inspection, every job could be thoroughly inspected before it was covered in, and any faulty work detected and eliminated. Until we get something of this kind dangerous work and incompetent workmen will be the order of the day, and the public will pay the bills some day when a first-class conflagration takes place as a result.

Let us have a competent inspector, let the inspector get around and inspect the work, let him see that every rule is complied with to the very letter, and then this "cheap John" wiring will become a thing of the past.

It would be entirely desirable to compel every electrician to pass an examination in the fundamental principles of his trade before entrusting to his charge any job of electrical work, no matter how small. The inspector might be chairman of a board of examiners of several members, chosen from among the practical electricians of the State, and until a candidate has passed a satisfactory examination he should not be allowed to take charge of any job.

A similar method is pursued in regard to steam engineers in many places, and are more lives and property at stake in the case of steam engineers than of careless or ignorant electricians?

Let us have, then, thoroughly competent workmen, proven so by some sure method, and a rigid inspection of the work done. The contractor, the workmen and the public in general will receive benefit from such a system.

Manchester, N. H. S. E. Sanborn.

[Assuming that the underwriters have sufficient business sagacity to properly look out for the vast money interest they have at stake, municipal electrical indoor inspection is superfluous. A double inspection—by municipal and underwriters' agents—can only result in annoyance and expense to the contractor, though, naturally, it will be welcomed by the insurance interest as an extra assurance of safety. Such municipal bureaus as proposed by Mr. Sanborn would inevitably become the prey of politicians, and the positions be filled through political favoritism and not merit. What may be expected in extreme cases was recently illustrated in New York City, where several of the officers of the bureau for the examination of stationary engineers were arrested on charges of bribery and blackmail on the complaint of engineers.—Ed]

The Hunter Alternating Current Patents.

To the Editor of American Electrician:

While you were kind enough to publish in your February number my criticism of your article appearing in the January number relative to my generic transformer patents, your editorial, in my judgment, is most unfair and misleading.

Your reference to the suit of Thomson-Houston Electric Company vs. East Reading Railway Company as evidence that the reasons I advanced for my assignees not suing on the Hunter railway patents are not true, is another example of making statements without a knowledge of the facts. Permit me to say that suit was brought under an agreement with me on my broad trolley patents, and the Thomson-Houston Electric Company had no intention of dropping it, and further could not have done so without *my* consent. For the reason that the Edison Company had joined issues with the Thomson-Houston Electric Company just prior to the time for arguing the case, I consented to drop it, and it was due wholly to myself and not the Thomson-Houston Electric Company that it was dropped. May be I made a mistake in dropping it, but that is another question.

Your reference to the prior art proves absolutely nothing. Neither Faraday, Ruhmkorff, Varley or Gaulard & Gibbs disclose in any sense the reduction of potential in a system of transmission due to the special construction of the induction coil itself. The Berliner and Rosetti patents do not show the invention, and have been held by the Patent Office is not anticipatory. You say that Gaulard & Gibbs demonstrated the reduction of potential in 1882. By their own writings, over their signatures, published in the Telegraphic Journal and Electric Review, Vol. 8, No. 408, page 293, they do not themselves claim any date prior to 1883, and that, too, after the date of my application of February, 1883. However, it is well known by those familiar with the facts that my invention dates as of August, 1881, which is anterior to these parties. A knowledge of this was known at that time to the Jablochkoff Company in Paris. Your reference to the Zipernowski and Deri patents needs no comment, as they are long after my reduction to practice. I might remind you that the court in the suit of the Westinghouse Electric Company vs. The Sun Electric Company decided in 1888 that the Gaulard & Gibbs patent did not embody the construction of a reducing transformer, but was limited to a series system, which might have a reduction of potential in the local circuits while employing a higher resistance secondary than primary, which is inconsistent with the methods in vogue, in which the ratio is 20 to 1, the former being the primary and the latter the secondary. Your reference to suspicion being attached to the issue of my broad patent is, therefore, without foundation and very objectionable.

You also make unjustifiable insinuations as to the acts of the Patent Office, built upon imaginary meanings placed upon my words relative to the fact that the public has yet considerable to learn on the transformer matters. The facts are neither warranted nor excusable on your part. Your entire editorial indicated an inate desire to detract. I do not object to honest, open criticisms, but misrepresentation and ungenerous attacks upon the Patent Office through me upon a false basis is not what we should expect at the hands of such a paper as yours. My objection is that you publish my statement of the facts and then falsify the basis of them.

R. M. Hunter.

Philadelphia, Pa.

[If Mr. Hunter believes that his electric railway patents are broader in scope than those of any one else, why does he not assert his claims under them? When in the Reading Railway suit an opportunity presented itself that would have enabled him to do so, he acknowledges that by his own act the issue was withdrawn.

As to the transformation of alternating current E. M. F., if Mr. Hunter will refer to Hall's "Manual of Magnetism," printed in 1849, he will find both step-up and step-down transformation there treated as a matter of common knowledge. Varley later described the closed magnetic circuit transformer, so that when the coming of the incandescent lamp opened up the field, the principles of the present commercial alternating current system were ready for application without further assistance from the inventive faculty than in the perfection of working details. Yet Mr. Hunter claims that by a patent issued in 1897 on an invention dating from 1881, he "covers the entire art" of alternating current operation and "all the apparatus employing transformers for reducing potential, now in use or likely to be used."

We do not understand Mr. Hunter's references to "insinuations as to the acts of the Patent Office" and "ungenerous attacks upon the Patent Office," for which assertions there is absolutely no basis in our remarks. We have dealt with facts, while Mr. Hunter, apparently, considers that his personality is the factor at issue.—Ed.]

The Jacques Cell.

To the Editor of American Electrician:

In reply to Prof. Anthony's letter, appearing in the February issue, there seems to be no reason to doubt the correctness of all the statements made by him in regard to his experimental observations, both on the Jacques cell and on the various forms of zinc battery which he has described. They seem to be in accord with previous observations made under similar circumstances. Nor is there anything in those observations to indicate that the oxygen used by him acts directly as a depolarizer, or does anything more than generate a depolarizer, which subsequently takes part in the electro-chemical reaction.

Prof. Anthony seems to have entirely missed the question at issue, so far as the Jacques cell is concerned, and in his experiments with the zinc cell he has failed to follow the directions and eliminate other influences. Consequently his experiments were not germane to the question.

That oxygen in the Jacques cell performs a function in the maintenance of current, there has never been any question. That function has been stated very clearly by Prof. Ostwald in the January issue of the American Electrician to be the re-oxidation of the iron, which becomes reduced by the electro-chemical reaction. He says the energy of the combination of this oxygen with the iron "is lost as far as the electrical process is concerned," and "the activity of the cell depends entirely upon the renewal of the exhausted ferric oxide, i. e., the amount of air or oxygen which is conveyed to the iron cathode." By the "activity of the cell" Dr. Ostwald evidently does not mean electromotive force, but the ability of the cell to maintain a currrent through a closed circuit, which is the only process that would exhaust material or necessitate a renewal of anything.

The experiments of Prof. Anthony simply corroborate these statements, and show that the maintenance of current depends upon the continuous renewal of the exhausted depolarizer. But what has this to do with the cause or source of the electromotive force? It is the cause of this electromotive force that is the question at issue, not the capacity of the cell in coulombs or ampere-hours. The electromotive force must exist before any current can flow, before any material can be exhausted or require renewal, and it does exist and is maintained before any oxygen is introduced, and even while the caustic alkali is saturated with illuminating gas. The electromotive force certainly cannot be caused by the renewal or regeneration of anything, especially of a by-product that results from the operation of the electromotive force itself. Neither can the cause of the electromotive force be dependent in any way upon the number of ampere-hours that may be taken from the cell before it requires a renewal of its depolarizer. The electromotive force of this cell remains unchanged as long as the composition of the electrolyte remains unchanged, and the temperatures of the iron pot and the inner electrode (whether it be of iron or carbon) remain constant and different.

In the February issue Dr. Thomsen states:

1. That the direct combination of two elements cannot evolve electrical energy.
2. That if the oxygen combines chemically with the iron none of the energy of that combination can be evolved as electrical energy.

He concludes, therefore, that the Jacques cell can evolve electrical energy as a galvanic battery, only on the hypothesis that iron at the temperature of the cell occludes oxygen without combining with it chemically. That is, the galvanic theory of this cell rests entirely on the hypothesis that oxygen at 500 deg. C. combines with iron without evolving its energy of combination or any considerable portion of it. But this hypothesis in regard to iron is entirely untenable. Dr. Thomsen offers no evidence in support of it, simply because there is no such evidence. Iron does not under any known condition occlude oxygen and does not combine with oxygen in any way except by the production of an oxide of iron and the evolution of more energy than the same oxygen would evolve in combining with carbon. The statements of Dr. Thomsen (aside from this entirely unsupported and incredible hypothesis in regard to the occlusion of oxygen by iron) leave no escape from the conclusion that the electrical energy of the Jacques cell originates in heat and in heat only.

Returning to the experiments of Prof. Anthony with zinc and sulphuric acid, we find from his own statements that he did not perform the experiments which I suggested, but introduced another depolarizing agent, that produced the effects which he attributed to oxygen. By allowing his copper tube to stand for ten or twelve hours in the dilute acid he produced a considerable quantity of copper sulphate in the electrolyte. This gave him a Daniell cell, with copper sulphate as a depolarizer, which on closed circuit deposited finely divided copper on the copper tube or carbon rod. Oxygen and sulphuric acid coming in contact with this finely divided copper, or even in contact with the unamalgamated copper tube, would rapidly convert it into copper sulphate. In other words, his electrode, like the platinum electrode, was capable of being rapidly oxidized by contact with the air.

I should perhaps have given more explicit directions and stated the precaution necessary to guard against other reactions than the one under consideration. Prof. Anthony claimed that in a cell consisting of zinc and platinum electrodes and an electrolyte of dilute sulphuric acid, oxygen gas forced into the cell acts directly as a depolarizer, without first combining chemically with some other substance; or, that the depolarizing effect would be produced by oxygen, if any inert conductor were substituted for the platinum. My suggestion was to substitute for the platinum in this cell either carbon or "a well amalgamated sheet of silver, lead or copper." It is essential that the metal shall be entirely free from oxide, thoroughly clean and thoroughly amalgamated. No impurities capable of alternate oxidation and reduction, such as salts of copper, should be present even in minute quantities. Such salts act as depolarizers on closed circuit, and are again regenerated by bringing the reduced metal in contact with air. All such bodies must evidently be excluded, if we wish to observe the effect of oxygen alone.

Instead of excluding these bodies, it is evident that Prof. Anthony introduced a large quantity of copper sulphate by allowing the copper tube (the condition of its interior being probably unknown to him) to stand ten or twelve hours in the acid. In such a solution, carbon also would act in the manner he has described. There is no necessity or advantage in using porous cups in this experiment, there being only one electrolyte and nothing to separate. In

Prof. Anthony's experiments the porous cups used only aggravated the effect of the copper sulphate by confining it to the immediate neighborhood of the copper or carbon electrode, and producing a Daniell cell of the typical form—an admirable arrangement for exhibiting the 1.04 volts which he obtained.

I have repeatedly performed the experiment under proper conditions, and found that the oxygen has no effect whatever, if it has no chance to first combine with something else. The amalgamated copper must be thoroughly washed in very dilute sulphuric acid, quickly dipped in pure water, thence into the cell and entirely submerged in the electrolyte. The circuit must be closed through a resistance of a few hundred ohms, allowing a small current to pass, in order to prevent as far as possible any oxidation of the plate. The potential difference should be measured as soon as possible, first without the current of air, but while the electrode is being rapidly shaken to prevent the collection of hydrogen gas. The air should then be introduced and the potential difference again measured. If the experiment is rapidly and properly performed to prevent the formation of copper sulphate, no effect is produced by the introduction of the air.

The same is true if we use mercury, carbon or amalgamated silver or lead instead of copper. I have obtained the same result also with dilute hydrochloric and even with dilute nitric acid. With dilute sulphuric acid as electrolyte and mercury as the electrode there is no danger of oxidation, and the only precautions necessary are that the mercury shall be agitated and the platinum or other wire used to make contact with the mercury shall be insulated from contact with the electrolyte and the air. It is understood that the zinc used in these experiments must be clean and thoroughly amalgamated.

The difference between the behavior of these metals and that of platinum under the same conditions shows that the depolarizing effect is due to the action of the oxygen on the platinum and not to the direct action of the oxygen itself.

I believe if Prof. Anthony will repeat these experiments, observing the precautions necessary to exclude all depolarizing influences except the one he alleges, he will find good reason for changing his opinion, though it may have been fixed, as he says, for twenty years.

In "effectually" disposing of my statements, Prof. Anthony again declines to explain how an electromotive force of 1.2 volts is produced without thermo-electric action betwen the iron rod and the iron cup. He adroitly shifts the burden of this explanation to the shoulders of "the German experimenter," to whom he has referred. If he refers to the work of Liebenow and Strasser, I will state that I am familiar with the experiments described by those investigators, but know of nothing in them to justify the statement of Prof. Anthony. They made no measurements of either electromotive force or difference of temperature between the iron cup and the iron rod. Their measurements were confined to determining the electromotive force between two electrodes inserted into fused alkali, one being a pipestem containing potassium chloride and the other a rod of carbon, iron, nickel or silver. Their results, as far as they go, show that the cause of the electromotive force is thermo-electric, though they failed to correctly interpret their own results. They found, for instance, that a difference of one volt may be obtained between two iron pipes inserted into the fused alkali and maintained at different temperatures. But they did nothing to show the cause of this electromotive force, if it is not thermo-electric, and they did not even hazard a guess as to its cause. The explanation they suggested of my experiments was a mere conjecture, not founded on nor supported by any of their results, but based purely on analogy and a theory of "passivity."

The only theory of oxidation or chemical action that can account for this phenomenon is the theory that the simultaneous oxidation and reduction of equal quantities of the same substance constitutes a source of energy—a theory, according to which two iron electrodes immersed in an electrolyte constitute not only a galvanic battery, but an inexhaustible source of energy.

If Prof. Anthony knows of any facts or results obtained by any experimenter which prove that the electromotive force between the iron rod and the iron cup is caused by oxidation and not by heat, why does he not give a statement of those facts, instead of a mere reference to a conjecture in a foreign language? The language in which these facts are said to be described must be capable of translation. Let the readers of the AMERICAN ELECTRICIAN have the facts and they can make their own conjectures.

Philadelphia, Pa. C. J. REED.

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EXPLORING THE POTENTIAL AROUND THE COMMUTATOR.

BY PROF. A. F. MCKISSICK.

The method here described, due to Mordey and given in S. P. Thompson's "Dynamo-Electric Machinery," is perhaps the most covenient for exploring the potentials around a commutator, and is as follows, reference being made to Fig. 1:

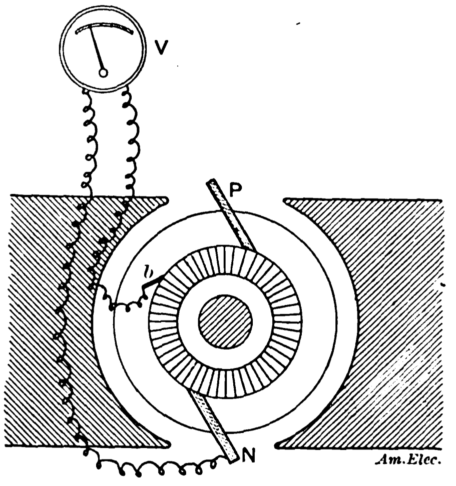

FIG. 1.—DIAGRAM OF ARRANGEMENT.

One terminal of the voltmeter, *V*, is connected to one of the brushes of the dynamo, and the other terminal is joined by a wire to a small pilot brush, *b*, which can be pressed against the rotating commutator at any desired part of its circumference.

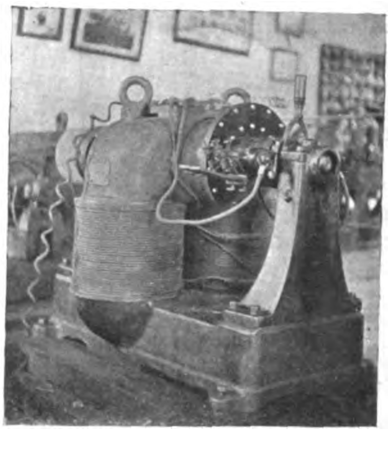

FIG. 2.—APPARATUS FOR EXPLORING POTENTIAL.

By plotting the results obtained, using potentials for ordinates and positions of pilot brush for abscissæ, we obtain the totalized or integrated curve of potentials. We can determine, by the aid of these curves, the relative value of different parts of the field and see whether there is a proper distribution of the lines of force.

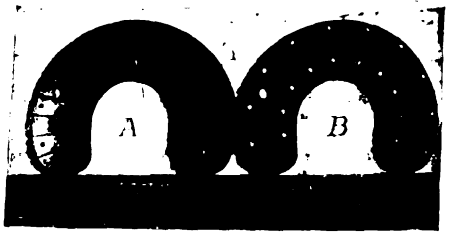

FIG. 3.—DETAILS OF APPARATUS.

The following simple piece of apparatus was constructed for the application of this method, Fig. 2 showing the apparatus attached to a machine, and Fig. 3, the parts of the apparatus.

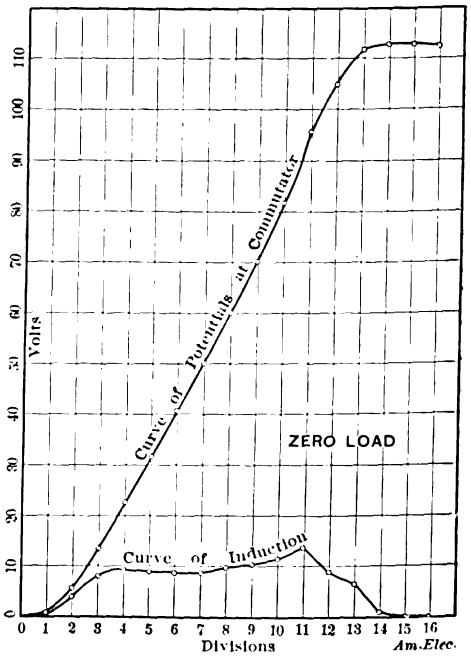

FIG. 4.—CURVE OF POTENTIALS, NO LOAD.

In Fig. 3 *A* is a piece of hard rubber ½ in. thick, slotted, as shown, at equal angular distances, and made to fit on the brush-holder rods of the machine to be experimented with. *B* is a cover of hard rubber, ¼ in. thick, attached to the piece, *A*, with screws. A brush of thin brass or copper, ¼ in. wide, is attached to one terminal of the voltmeter, the other terminal of the voltmeter being connected to one of the brushes (see Fig. 1); by pushing this brush in each slot until a firm contact is made with the commutator, we get the successive readings.

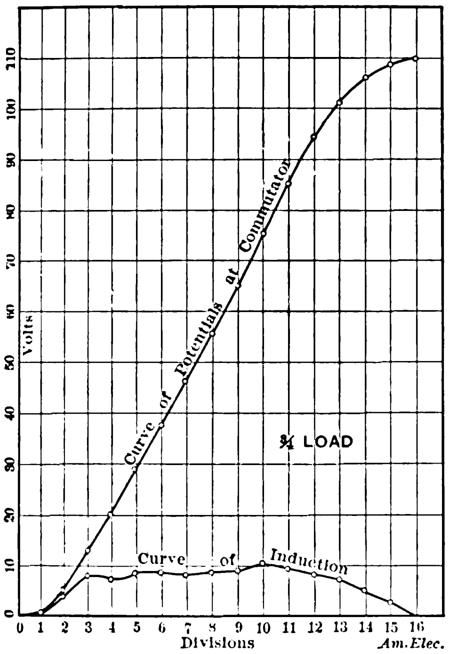

FIG. 5.—POTENTIAL CURVE FOR THREE-QUARTERS' LOAD.

In Fig. 4, the curve of potentials at the commutator was obtained with the apparatus, the dynamo working at no load. The curve of induction, shown on same sheet, was plotted by taking the differences of successive readings. The ordinates of this curve of induction do not give us the potentials of a single coil in successive positions, but the potentials of equal successive divisions of the commutator.

In Fig. 5 the same curves are plotted for three-quarter load.

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NOTES.

Electrical Equipment of Third Avenue Street Railway, New York.—The Third Avenue Railway will soon begin to change from cable to electrical equipment. The services of Dr. Louis Duncan, of Johns Hopkins University, have been secured as consulting engineer.

The Omaha Exposition.—The Omaha Exposition Company has ordered 2155 k.w. of General Electric dynamos and transformers for illuminating purposes alone. Among the apparatus are four 125-light arc dynamos of the Brush multi-circuit type; four 120-k.w. and two 180-k.w. alternators and a 225-k.w. direct current generator for power purposes. The exposition promises to be the most extensive ever held in this country, excepting the two, Philadelphia and Chicago, World's Fairs.

Economy of Steam Pumps.—Elaborate tests were recently made on board the U. S. S. "Minneapolis" on the consumption of steam per h.p. per hour by the auxiliary machinery, the exhaust being condensed and weighed. Of six steam pumps tested, No. 1 (1 h.p.) consumed 204 lbs. of steam per 1 h.p. hour; No. 2 (.78 h.p.), 318 lbs.; No. 3 (6.4 h.p.) 155 lbs.; No. 4 (2.5 h.p.), 170 lbs.; No. 5 (8.8 h.p.), 91 lbs.; No. 6 (1.5 h.p.), 242 lbs. Of three dynamo engines, the consumption of No. 1 (33 h.p.) was 68 lbs. per 1 h.p.; No. 2 (35 h.p.), 56 lbs.; No. 3 (27 h.p.), 72 lbs. All of the above were working condensing when being tested.

A Confidence Man.—We are advised by a subscriber in the City of Mexico that he was recently victimized to the extent of over $1,000 by an electrician calling himself Paul Freeman, and that he learns this same man is now using his name in similar transactions in the United States. In Mexico Freeman represented that by going to New York he could arrange for consignments of goods on very favorable terms. When sent there for that purpose, he succeeded, by means of drafts on his Mexican employer in obtaining a large sum of money, and then for a time disappeared from sight. Our informant states that recently, however, he has learned that Freeman is using his name with American merchants, to whom he represents that he has large orders for electrical supplies from Mexico.

Municipal Ownership.—Mr. M. J. Francisco has issued a fifth edition, with statistics to date, of his well-known book on "Municipal Ownership vs. Private Corporations." As the author has personally examined nearly all of the municipal plants in the United States and Europe, he is well equipped to write on the subject, and makes a vigorous presentation of the case against municipal government, well supported by statistics. Under the head of "Municipal Plants and Their Records," the towns owning plants are taken up alphabetically and the history of the plant given, together with data as to cost of lighting from the same. Another list is of municipal plants sold or abandoned, of which thirty are enumerated. The pamphlet, which will be found interesting reading by both opponents and advocates of municipal ownership, may be procured from the author, at Rutland, Vt.

A Boston Central Station.—The Boston Electric Light Company, which up to the present has obtained current for its lines from a number of stations scattered throughout the city, recently decided to concentrate all generating machinery in a single building, to be erected in South Boston. The three-phased alternating current system will be used and four General Electric machines, each of 1,500-k.w. capacity, are to be installed, with a reserve of 50 per cent., making a total capacity of 12,000 h.p. The dynamos are to be of the revolving field type, and will generate current at 2,200 volts. There will be two synchronous motors of 100 h.p. each for driving exciters, and no less than 18 synchronous motors of 200 h.p. each, which will drive arc-lighting machines. There will also be two rotary converters of 500 k.w. each to supply power circuits with direct current at 550 volts. For incandescent lighting the present circuits will be supplied from the three-phase wires, using the transformers now in place.

Testing Insulators.—In the article on the Butte, Mont., electric power transmission plant in the February issue, an error—not due to the writer of the article—occurred in the description of the method of high voltage insulators. The arcs are established, not between projecting pins and the surface of the water in the insulators, as stated, but between quarter-inch gaps in series in the testing circuit and between the insulators. Twenty pins are mounted in a frame, the lower ends dripping into water contained within the same number of inverted insulators. When the testing circuit is closed, sparks jump across the gaps in series, and the character of the spark determines the condition of the corresponding insulator. As twenty insulators are tested at a time, this corresponds to a total spark-length of 5 inches. The transformer employed will support a spark 6½ inches long.

Under-Running Trolley Decision.—Judge Lacombe of the United States Circuit Court of the Southern District of New York has rendered a very important decision affecting the Van Depoele fundamental patent on the trolley arm, which in effect reverses a previous decision by Judge Wallace, and sustains the patent. It is claimed by those interested that the decision of Judge Lacombe gives to the owners of the Van Depoele patent an exclusive right to the use of the overhead trolley. On the other hand, it is asserted by the opposite side that the decision, while it sustains the claim as to the use of a pivoted arm connecting a trolley wire with the car, this claim mentions no springs or other means for holding the arm in continuous contact with the overhead wire; consequently, the device as described is inoperative, and the spring supported trolley pole does not come within the range of the decision.

Electrolytic Chlorine.—In a recent paper Mr. C. F. Scott described the electrolytic process employed at the works of the Matheson Alkali Company, at Niagara Falls. The raw material, common salt, (chloride of sodium) dissolved in water, is fed into a cell built up of slate slabs, and the current entering at one carbon terminal, or anode, carries the metallic sodium with it to the mercury cathode, where it unites with the mercury, forming an amalgam. The chlorine, the other element of the salt, is liberated at the other carbon terminal, where it is drawn off by means of an electrically driven exhauster. The cell is divided into three compartments, and is arranged to rock back and forth. The two outside compartments are alike, while the central compartment is somewhat different. Here the mercury and amalgam form the anode and an iron grid the cathode. Water is fed into this compartment, the current causing it to unite with the sodium of the amalgam, forming sodium hydrate of caustic soda. The hydrogen liberated passes oft into the air. There are now two useful products from the cell—chlorine gas and caustic soda. The caustic liquor is conveyed to huge kettles, where the water is driven off by heat, the finished caustic being a solid substance of almost snow whiteness. The chlorine gas is conveyed to lead chambers, the bottoms of which are covered with layers of slacked lime to the depth of about four inches. This lime being finely powdered, acts as a sponge, absorbing the chlorine gas. The lime contains from 35 to 38 per cent. of chlorine.

Electrical Exhibition.—The list of exhibitors who have contracted for space at the electrical exhibition to be held in Madison Square Garden in May, already numbers more than one hundred, being no less than five times as many as were booked at the corresponding period preceding the 1896 show. As many have taken a much larger space for the present exhibition, the proportion on that basis is even greater. One of the features of the exhibition that will be much appreciated is an operative exhibit consisting of a complete reproduction of a section of the under running trolley in use on Madison avenue, in New York. The section will be complete in every respect with the yokes, tracks, etc., blocked up above the floor, that the method of making contact may be clearly seen. On the track will be a car fully equipped and capable of actual operation. A telegraph tournament will be held in connection with the exhibition, when a contest will take place for a prize for high speed of transmittal; there will also be a typewriter receiving contest. Mr. James D. Reid, the historian of the telegraph, a friend of Morse, and a worldwide known telegraphic pioneer, will be one of the judges.

Electric Heating— In a paper read before the recent annual meeting of the American Paper and Pulp Association, Dr. Bell said that the question of electric heat for the drying rolls, and generally for freeing the pulp from water, has been several times broached to him recently, and added: "It is only fair to say right now to those interested that the amount of power required to furnish heat for drying the daily product of a modern paper mill is enough to stagger the wildest-eyed and longest-haired electrical crank who ever claimed that electricity was in its infancy. That drying by steam is expensive is painfully evident to anyone in the business, but if you are minded to seek for improvements do not take up electrical heating until you have exhausted the possibilities of producer gas." Mr. C. F. Scott at the same meeting said that some time ago he was written to by a mill owner regarding the heating of rolls in his paper mill by electricity. He stated a 100-h.p. boiler did the work, but he would like to use electrical apparatus, as he had a water power which would give 100 or 200 h.p. "A 100-h.p. boiler," Mr. Scott said, "is one which will supply steam to an engine which will give 100 h.p. output; the actual energy which is in the steam and which is effective for heating is about 1,000 h.p.—a 1,000-h.p. electric plant would be required to replace a 100-h.p. boiler. The steam plant has an actual efficiency of about 10 per cent. for supplying mechanical power, or an apparent efficiency of about 1000 per cent, when used for heating."

Electrical Equipment of Brooklyn Elevated Railways.—The Brooklyn Elevated Railway Company awarded a number of important contracts on Feb. 23 for the equipment of its lines with electric power. The first order called for twelve motor cars, each to be equipped with four Walker 80-h.p. motors, and later other cars will be ordered until the road is entirely equipped. The Sprague multipolar unit system will be used, and the third rail method of taking currrent, as applied on the Chicago roads, will be employed. The motors were designed by Prof. Short, of the Walker Company, especially for elevated railway service, and will be built upon the lines of generators. The frame will be circular in form, and contain four laminated field magnets with pole shoes. The armature is hollow and provided with air ducts running laterally through the laminations to insure perfect ventilation. Both the magnets and armature will be wound with bar copper, with only one turn on the armature for each commutator bar. The modern practice of very few slots in the armature is followed, with four conductors in each slot. The insulation of the magnet coils will be of asbestos, while mica will be entirely used in the insulation of the armature.

Aluminum as an Electrical Conductor.—Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, in a recently published pamphlet calls attention to the advantages of aluminum as an electrical conductor. The electrical conductivity of commercially pure aluminum is 63 per cent that of copper, and its tensile strength is 26,000 lbs. per sq. in. for pure soft iron, and 40,000 lbs. for hard drawn wire. The specific gravity is 2.16, and as that of copper is 8.93, the latter, therefore, is 3.33 times heavier than an equal volume of aluminum. Comparing cost, the weight of one mile of No. 10 copper wire is 162.32 lbs, and its cost at 14 cents per lb. would be $22.72; the weight of aluminum wire of the same conductivity would be 77.91 lbs., and the cost $22.58 at 29 cents a pound, at which price aluminum electrical wire can be procured on the market at the present time for large orders. A great advantage is that the strength of aluminum wire is 60 per cent greater than that of copper wire of the same conductivity, and consequently it can be used in much longer spans, thus reducing the number of poles and insulators. Experiments are now being made by the Pittsburgh Reduction Company to show that a wire of aluminum alloy can be furnished with a tensile strength of at least 65,000 lbs. per sq. in., and an electrical conductivity of more than 50 per cent that of copper. The tensile strength of copper wire, it may be added, is 65,000 lbs. per sq. in. when hard drawn. As an instance of the advantages of aluminum for electrical conductors, it is stated that in the Chicago Stock Yards a mile of aluminum wire of No. 11 gage replaced a telephone line of copper wire that had become badly corroded on account of its being frequently subjected to sulphur gases from passing locomotives. The aluminum wire is giving good satisfaction, and withstanding the corrosion much better than the copper. Since aluminum has a very much higher conductivity than brass, its superiority to that material is pointed out for use in electrical apparatus. Aluminum parts can be furnished at a price 10 per cent cheaper than brass, section for section, its weight, of course, being very much less.

Niagara Power.—In our January issue appeared a notice of the apparatus to be installed by the Buffalo Railway Company in order to utilize electric power from Niagara. The Buffalo General Electric Company has since then completed its plans for the utilization of Niagara power, and it is expected that within six months the city of Buffalo will be entirely lighted by electricity transmitted from the Falls. The first contract covers eleven 250 k.w. air blast transformers, wound for 11,000 and 22,000 volts, and stepping down to 352 volts, secondary. The transformers will be fed by two independent sets of cables, so that light and power service will not be interrupted in case of break-down of one set of cables. Owing to the low frequency of generation at Niagara—25 periods—the current for lighting will be raised to 60 periods by motor generators, each of which will be of 400 k.w. capacity. For generating direct current for arc lighting, there will be thirty 125-light Brush machines, direct coupled in pairs to fifteen 250-h.p. synchronous motors; 500-volt direct current for ordinary power service will be obtained from two 200-h.p. rotary converters. The total capacity of the plant, all of which is to be supplied by the General Electric Company, will be 5900 h.p., furnishing current for 3750 arc lamps, 24,000 incandescent lamps and about 600 small motors.

Cost of an Electric Transmission Plant.—In a paper read before the recent annual meeting of the American Paper and Pulp Association, Dr. Bell gave an estimate for an electric transmission plant to deliver 1,000 h.p. at a distance of ten miles from a water power. Allowing 1000-k.w. capacity in the power house, with a generator in reserve, there will be three 500-k.w. machines direct connected, if the speed of wheels will allow. The market price of such machines, complete with station equipments, and wound for 5,000 or 6,000 volts, will, including installation, not exceed $10,000 each. The present tendency is toward high-voltage generators, connected directly to the line for such cases, although low-voltage generators with raising transformers can be obtained not far from the same price. In any event, reducing transformers for 1,000 h.p. would have to be installed in the mill, of which the aggregate cost in large units would not exceed $5000 to $6000. The 1000 h.p. in motors would be needed for driving the various parts of the mill, and assuming units of 100 h.p. or more, the probable cost of these motors would be $15,000 to $20,000, depending somewhat on the size and speed of the various units. This completes the necessary electrical machinery. The line, assuming, say, 6,000 volts delivered and 10 or 12 per cent. drop, could be erected with all copper up for less than $20,000. Altogether, the machines at both ends of the line could be installed, including a suitable station, for about $80,000; under favorable conditions for somewhat less. The cost of the water privilege and the necessary hydraulic work is the most uncertain factor in working out any assumed case of power transmission. It may fall even to $25 or $30 per horse-power, and it may rise to $150 or $200. Taking the general average of powers in regions where they have not yet acquired an artificial value by proximity to towns, one may say without being widely astray that $75 per horse-power will cover the necessary expense. With a considerable head this figure will be somewhat reduced. For a rough estimate of the hydraulic cost in the case in hand, it will be fairly near the mark to double the cost of the electrical part of the equipment, making $160,000 as the total investment in the power plant for furnishing 1,000 h.p. day and night. This figure is stated to be a conservative one, as a certain plant with a generating station of 1000 h.p. was installed complete, including distribution lines to the amount of $15,000, but no motors, for less than $25,000, and this at a time when electrical machinery was considerably more costly than at present. As to operating expense, the figures are not difficult to secure. In the first place, there will be for interest on the investment at 6 per cent., and an annual charge of 4 per cent. to the credit of a sinking fund, for depreciation of replacement. Then adding 2 per cent. for insurance and taxes, the total annual charge due to these items becomes $21,600. The regular operating charges can be made up about as follows: Labor, eight men and team, $6,500; supplies and general maintenance, $5,000. These figures are more than ample for any ordinary case. Summing them, $33,100 is the total annual cost of 1,000-h.p. for twenty-four hours per day, which brings the charge per horse-power per year down to $33.10. This power generated by steam, with coal at say $3 per ton, using the non-condensing engines too often employed, would cost at least double the amount mentioned, and even with a first-class steam plant the cost would fall little, if any, below $50 per year. In other words, the net yearly saving by employing electrical transmission in such a case as assumed amounts to from $15,000 to $30,000 per year, which figure could often be exceeded under the conditions actually existing in paper-mill work.

The Diesel Motor.—For some time our foreign exchanges have devoted much space to the recently invented Diesel motor, which is claimed to embody principles that insure an extremely high efficiency of the apparatus as a heat engine. This motor is, like the gas engine, an internal combustion heat engine, the fuel being gas, petroleum or powdered coal. The peculiar features of the motor are an initial compression of the air in a separate cylinder, and the utilization of the compounding principle. There are three cylinders, one of which is considerably larger in diameter than the other two. The air undergoes an initial compression in one side of the larger cylinder, from which it is discharged into a reservoir. It is then admitted into one or the other of the smaller cylinders, where it is finally compressed to a very high temperature—about 1000 degs. Fahr. At the end of the compression stroke the fuel is injected, and a gradual combustion ensues, which completely consumes all of the fuel and without the usual explosion. The gases are then exhausted from the smaller into the other side of the large cylinder, where they do work through expansion, being exhausted into the air on the return stroke. The injection and combustion of the fuel can be regulated automatically according to the power required, and thus the speed retained constant at all loads. It is claimed that in practical operation during the past nine months the Diesel motor has shown that it can turn into mechanical work 26 per cent of the heat units of the fuel consumed, which gives it a commercial efficiency about twice that of the best steam engine. Another advantage claimed for the motor is that it can be set to work without loss of time, as it is started by simply opening a valve admitting stored compressed air into the cylinder. In operation it runs almost noiselessly and without shock or jar, in this respect differing materially from the usual gas and oil engine.

Electricity in Paper Making.—At the annual meeting of the American Paper and Pulp Association, held in New York last month, Dr. Louis Bell and Mr. C. P. Scott read interesting papers on the application of electricity to paper making. Mr. Scott prepared his paper with a simple account of the characteristics of electricity and electrical apparatus, and then proceeded to show in what way and under what conditions they may be made profitable in the paper making industry. Both the direct and the alternating current systems were described, and the conclusion arrived at that the requirements of pulp and paper mill service are such that the polyphase alternating current system is in general better adapted than the direct current, owing largely to its flexibility, the simplicity of the alternating current motor and its ability to stand acid fumes, dampness, the severe strains of sudden stoppage, and long continued service. As to the advantage of electricity in general, it will enable the power to be brought to the mill, which can be located at the most convenient spot, instead of having to go to the power, while electric transmission enables the energy of separate water powers to be concentrated at one point. In distribution of power within it enables a great saving to be effected in shafting, greatly reduces the loss from friction, introduces great flexibility, and is desirable from considerations of convenience. Mr. Scott doubts the advisability of the application of electric motors attached directly to each part of a paper machine, owing to the expense that would be entailed by the necessary regulating and adjusting apparatus. Dr. Bell in summing up his paper said the best field for the use of electric motors in paper manufacture is in reducing the cost of power by utilizing the now well-tried methods of power transmission. By this means a mill can be located so as to obtain its materials and ship its product economically, without foregoing the advantages of cheap water-power. With the transmitted energy at hand, power can be economized by the skillful use of motors in its distribution. There is no cut and dried rule or formula by which the best equipment can be at once determined. Each case has to be considered on its merits, and by the light of common sense, for in the last resort the best equipment is the one which enables a given grade of paper to be turned out at the lowest price. Concerning the distribution of power in the various parts of a mill, Dr. Bell does not think the saving is enough to justify the use of an electrical system for distributing the power except in connection with a transmission plant. It is quite as important to know when to let well enough alone, he says, as to have a prophetic instinct for improvements.

Sensational Newspaper Science.—A recent number of *Science* has an article entitled "Time Wasted," protesting against the evil results of the exploitation of science for sensational purposes. "During the century which is now approaching its end," it says, "scientific discoveries and their applications have been so numerous and so far reaching as to practically revolutionize conditions of material existence, and they have often been so wonderful in character that it ought not to excite surprise to find intelligent people ready to accept without question announcements of inventions and discoveries of the most improbable and absurd character. Along this line the evil influence of a sensational press is enormous." "Unfortunately," it adds, "some men, who may be said to inhabit the fringe of genuine scientific activity, lend themselves to this sort of thing and are made much of accordingly. Whole pages of this modern journalism are filled with accounts of discoveries that *are going to be made*, for writers of this class are shrewd in taking advantage of the fact that human interest and human memory are now practically restricted to about twenty-four hours' time." An unfortunate result of this is that there are many very intelligent and thoughtful people, who ought to constitute the best support of scientific work to whom "the line separating the genuine accomplishments of honest scholarship are the output of sensationalism, which ought to be clear and sharp, is becoming very nebulous, and there is imminent danger of a revolt against the whole thing." The writer of the article had evidently in view some of our electrical wizards.

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Diagrams of Electrical Connections.

In the present issue the supplement, "Diagrams of Electrical Connections," is bound in the body of the paper, retaining its own paging, and perforated so that it may be easily separated. This will insure even margins, and obviate complaints we have received that the separate sheet was omitted by the binder. A portfolio for the sheets may be obtained from the publisher for 30 cents, postage included.

The Diesel Motor.

In another column we give a brief description of the Diesel motor, which has recently been attracting so much attention abroad. It is said that fuel in the form of a powder may be fed to this motor, but we doubt if it will be used otherwise than as a gas or gasoline engine. As such, however, it possesses two important features—both conducive to economy— high compression and secondary expansion. The air is compressed in two stages to a temperature in the neighborhood of 1000 degs. Fahr., and the graduated gas or oil charge admitted at the end of the second stage, when it is at once ignited. The mixture of air and gas produces a high temperature, and therefore pressure, without explosive action, and after expansion to the end of the stroke, passes into a larger cylinder, where it does further work, finally exhausting into the atmosphere. The two smaller cylinders each work on the Otto cycle, as in the case of the ordinary gas engine. One half of the large cylinder is used for initial air compression, and the other half, during alternate revolutions, works expansively the exhaust from one or the other small cylinders. The motor is thus a combination of two single cylinder gas engines, with a single acting expansion cylinder in common.

The Cost of Steam Power.

At the December meeting of the American Society of Mechanical Engineers, Mr. F. W. Dean gave figures to show that the very best steam generating plant of 1000 h.p. can be installed to-day complete—including buildings, chimney, compound engines using 12.5 lbs. of steam per h.p.-hour, boilers evaporating 9 lbs. of water per lb. of coal, economizers and all accessories—for $57 per indicated h.p. Such a plant can be run on 1.4 lbs. of coal per indicated h.p.-hour, and on this basis it is shown that the cost of a yearly h.p. of 10 hours per day will be $17.84 with coal at $3.85 a ton. This includes an allowance of 5 per cent for interest, 3½ per cent for depreciation, 2 per cent for repairs and 1 per cent for insurance and taxes.

For comparison with the cost of water power, it is desirable to know the estimated cost of an annual steam h.p. on the basis of 24 hours per day. If in Mr. Dean's estimate the items of depreciation, cost of repairs, oil, waste and supplies are doubled, and allowance made for two shifts of men, such yearly cost would amount in round numbers to $35 with coal at $3.85 a ton. In the bituminous mining regions coal can be purchased at the mines at the rate of 50 cents per ton, and on this basis the cost of an annual 24-hour h.p. is reduced to $19.

As stated before, these estimates are made on the basis of 1000 h.p., and while for plants of a larger size there would, of course, be a reduction, such reduction would be at a comparatively low rate in the case of steam plants. On the other hand, the reduction in cost for water power plants where the quantity of power is large, will usually be quite considerable. Nevertheless, the low cost at which steam power may be generated should not be lost sight of in considering a water-power electrical generating scheme.

Condensation in Steam Engines.

As has been shown in these pages, the working efficiency of steam engines may be as high as 70 per cent—by working efficiency being meant the ratio of the useful work of an engine to the entire amount of the heat energy supplied it that is available for transformation into work. In many engines, however, this efficiency is 50 per cent or even below, and the difference is largely or entirely due to internal condensation, which source of loss, it should be added, is usually not entirely absent from the most efficient types of engines. It is therefore of interest to take a glance at the conditions which cause this condensation, and see what remedy suggests itself.

During exhaust, the condenser side of the cylinder of an engine is cooled, the tendency being for the temperature to drop to that of the condenser—say 110 degs. F. When the steam valve is opened on the return stroke, by contact with the cooled surfaces part of the entering steam, if not considerably superheated, is condensed, thus doing no useful work. During admission the walls of the cylinder are also heated up to nearly the temperature of the entering steam.

When expansion begins, the pressure in the cylinder falls, part of the water condensed is re-evaporated, and the cylinder walls are again cooled. On the other hand, expansion under work is itself accompanied by condensation. At the end of the stroke there are left in the cylinder part of the water condensed at admission, and water condensed during expansion, while the cylinder walls have been cooled by re-evaporation. As soon as the exhaust begins, the great reduction of pressure causes, in most cases, complete re-evaporation, which increases the back pressure and further cools the cylinder walls.

That is to say, part of the heat received at admission is on the return stroke delivered to the condenser without doing work. The result is thus somewhat as if in a perfect engine the efficiency were lowered by having a by-pass from the admission side of the cylinder to the condenser, through which at each stroke a certain amount of steam passed. Or the condensation is equivalent to a leakage past the piston into the exhaust. The amount of re-evaporation at the end of stroke is sometimes as high as 50 per cent of the weight of the total steam condensation, and in single cylinder engines is rarely below 15 per cent.

The obvious remedy is superheating, and multiple expansion engines present an ideal case for its application. Superheating the steam initially is attended with difficulties, but in the case of engines having receivers the matter is a simple one, as it is then merely necessary to introduce into tubes in the receivers steam direct from the boilers. There can be no doubt but that great economy may be thus obtained, and it is notable that recent engines which have shown extremely low steam consumptions were fitted with receiver heaters. It should be added that there is a limit to superheating, beyond which it becomes a disadvantage. This limit would appear to be reached when all the steam at release is just saturated, though considerations relating to the normal condensation due to the performance of work may still further reduce the limit. As to the employment of steam jackets for the prevention of condensation, if on the high pressure cylinders, they will do some good, but owing to the thickness of the cylinder walls, the amount of heat passed through will be much less than can be imparted through thin reheater tubes, against which, moreover, the steam impinges in its passage. If on the low pressure cylinder, the jacket is little less than "a furnace for the condenser."

Charge for Telephone Service.

Judge Cox, of the District of Columbia, has decided that a telephone subscriber cannot allow his telephone to be used by outsiders, such use being pronounced an abuse of the time of the telephone operator, an infringement of the rights of the telephone company, and an infringement of the rights of other subscribers. This decision appears to have aroused considerable indignation in Washington, but it is difficult to see that any other view of the question could have been taken. A telephone company maintains a special plant for a certain service, and it would seem that it is entitled to charge for every use of that plant. The charge for service, it must be assumed, is based upon the cost—direct and indirect—to the company, and if a subscriber permits unauthorized persons to use his telephone, he increases that cost, or causes additional labor to the employees, for which neither employees nor company receives compensation, such use being also apt to interfere with the service of other subscribers.

Judging from the statements of the subscriber who instituted the suit, the trouble in Washington arose, not so much from a denial of the above principles as through what appears to have been lack of judgment on the part of the telephone company. This subscriber, who paid for two telephones, one in a warehouse and another in a hotel owned by him, states he was informed that he could not use the hotel telephone to talk to the warehouse without extra charge, unless the conversation related to hotel business. Should this be a correct statement of fact, it is yet another illustration of the too frequent lack of diplomacy on the part of those who, as servants of the public, should cater to its prejudices instead of assuming an attitude inviting conflict.

Idle Current.

In our last issue we pointed out a rational method of viewing the power factor, and defined it as a fraction expressing the part of the impressed E. M. F. usefully employed, the remaining portion of the impressed E. M. F. being "held up" in a circuit containg inductance, by the inductive E. M. F. generated in the circuit by the current flowing. Another term often very vaguely understood is "idle current," but this admits also of rational explanation.

Suppose we have an alternating current motor connected to a 100-volt circuit, and that at a certain load 10 amperes of current flow. Now connect up a condenser with the motor, either in series or in parallel, and of such a capacity that the motor's inductance will be neutralized. The alternating current will now pass through the motor as if its circuits were non-inductive—that is, the alternating current will meet with no more hindrance than would a direct current flowing through the same circuit. Owing, however, to this latter fact, the power of the motor would, under the conditions assumed, be increased by an increased flow of current, and to keep the machine down to the same brake power as before, suppose we insert a non-inductive resistance in circuit. Now, if by means of a voltmeter we find the resistance between the terminals of the motor 80 volts, then with 10 amperes of current flowing, the power factor of the motor at the assumed load will be .8. That is 80 volts represent the useful E. M. F. of both cases, and 20 volts the amount that had been "held up" by inductance in the first case.

Now, if we remove the resistance it will be necessary to reduce the flow of current to 8 amperes in order that the motor shall run under the same conditions—that is, consume 800 watts—as the impressed E. M. F. has again become 100 volts. That is to say, the motor when working at the same load requires 10 amperes of current when it is inductive, and 8 amperes when it is non-inductive. It is usual to say that the extra current required in the first case is idle current, but it will be seen that more current is required because in the first case part of the impressed E. M. F. is idle, and this is the more correct way of looking at the matter.

In other words, instead of assuming the excess of the product of the volts and amperes over the true watts to be due to idle current, it should be considered due to an idle E. M. F.—an E. M. F. "held up" by the inductive E. M. F., to repeat a somewhat inelegant term. Current is never idle, and in receivers is the primary factor, E. M. F. being secondary to it. In the case of a motor—direct currrent or alternating—there is a counter E. M. F., and if the impressed E. M. F. that balances this counter E. M. F. is cut down, more current must be sent through the machine if it is to continue to work at the same rate. Or to state it more directly, if a direct current motor has its E. M. F. reduced from 100 to 80 volts, the current sent through it must be increased in the inverse ratio in order that the motor may develop the same power; and similarly, when inductance balances part of the E. M. F. supplied to an alternating current motor, the current must be increased to maintain the power. In both cases all of the current does work; in the first case, the 20 volts are actually lacking, while in the second case they are present but neutralized—that is, idle, so far as the power of the machine is concerned.

A CHEAP TESTING SET.

The Wheatstone bridge is one of the most valuable instruments that can be devised, not only for its primary office of measuring resistances, but for testing faults of any kind. Most beginners are not aware that a convenient substitute can be made that will answer in many cases, and the expense of which need not exceed two or three dollars. Following, a description of such an easily made apparatus is given, and it may be of interest to those anxious to possess a testing set and do not feel that they can afford the large sum usually asked for such an outfit.

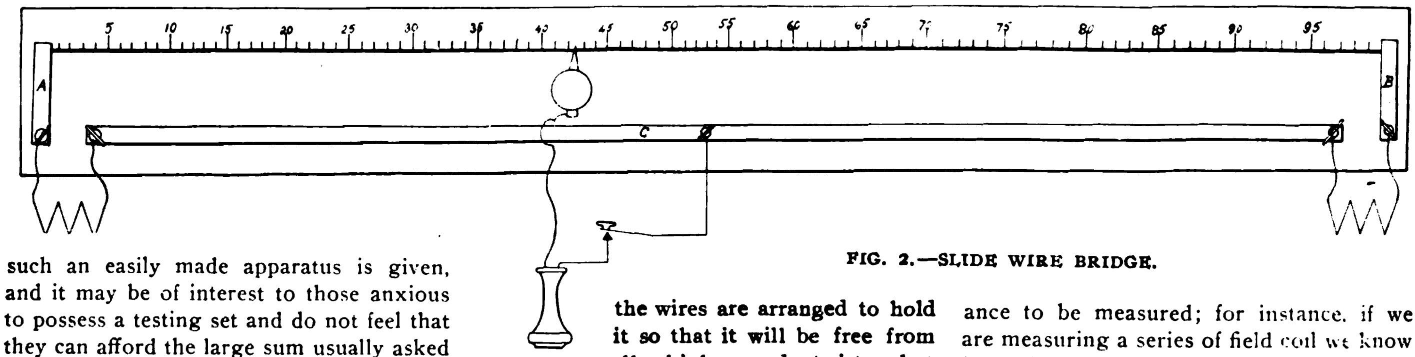

FIG. 2.—SLIDE WIRE BRIDGE.

Select a board of some dry wood and shape it nicely to the dimensions of 42 ins. long by 8 ins. wide. Procure some flat copper rod which is at least ½ by ¼ of an inch in sectional area. Of this there should be one continuous bar 36 ins. long, and two shorter pieces about 3 ins. long. Then secure a good straight piece of German silver wire, about No. 14, Brown & Sharpe gauge. Go over this with a micrometer, testing it at every inch in its length, and be sure that the piece selected is of uniform diameter and has no nicks or marks of any kind.

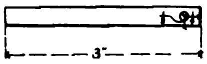

FIG. 1.—COPPER BAR.

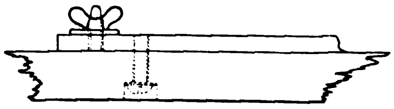

FIG. 3.—METHOD OF FASTENING TERMINAL BLOCKS.

With a suitable size of drill, bore holes ¼ of an inch from the ends of the short pieces of copper rod, and ⅛ of an inch from the flat sides, as shown in Fig. 1. The wire should now be soldered into the copper block, care being taken that it comes exactly flush with the block, no drops or beads of solder appearing around the joint. To do this, the better way is to heat the copper block very hot and thoroughly tin the inside of the hole and fill it with solder, which, if the block is hot enough, will remain melted. Having previously tinned the outside of the wire, insert it in the hole thus prepared, pushing it straight in until the proper distance has been reached. Be very careful not to pull it outward unless the solder does not fill well around the hole where it enters, because any outward pull of the wire would draw a meniscus of solder around it, which would be undesirable. The length of wire between the two connecting blocks, as shown in Fig. 2, should be exactly one meter long. This should be most carefully adjusted for accuracy.

The copper blocks are provided with binding screws at their terminals for the convenient insertion of known and unknown resistances, and are secured to the board, as shown in Fig. 3, by screws passing up from beneath. The blocks carrying the wires are arranged to hold it so that it will be free from all kinks and twists, but not to put any mechanical strain upon it, which might change its resistance; in other words, the wire should be straight, not stretched. A little platform of thin wood or pasteboard should now be built up underneath the wire so that it will support it throughout its length, and on the top of this strip of pasteboard should be pasted a meter scale; if the wire has been accurately adjusted, it will exactly fit between the terminal blocks. If these directions and the drawings are carefully followed, the result will be a bridge of considerable range.

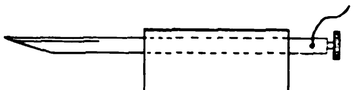

FIG. 4.—WEIGHTED INDEX.

To use this instrument, a source of E. M. F. is connected to the end blocks and a galvanometer, or, as shown, a telephone receiver, is connected to the long middle block, and its other terminal to a weighted index, which can be moved along the board between the wire and the long copper rod and make contact with the former at any point desired. This index is preferably made of a brass rod, one end of which has been filed up to a V-shape and drawn out to a sharp point, as shown in Fig. 4. The other end of the brass rod is conveniently shaped up into a binding post, to which the detector terminal may be attached; the weight may be a piece of lead cast about it and suitably shaped. The sharp edge of the brass should be very soft in order not to mar the wire at the point where it rests upon it, and for that purpose should be annealed by heating it in a flame and allowing it to cool slowly. A few standard resistances should be provided; one, ten and one hundred ohms will be sufficient. These may be conveniently made by measuring off the proper amount of insulated wire with a testing set, coiling it about a small wooden block and inserting it in a short piece of large brass tubing, which is then filled with paraffine. These coils may be made of moderately fine wire and stout, projecting terminals of as nearly no resistance as may be, lead out through the paraffine for purposes of connection. Fig. 5 shows a section of such a coil prepared for use.

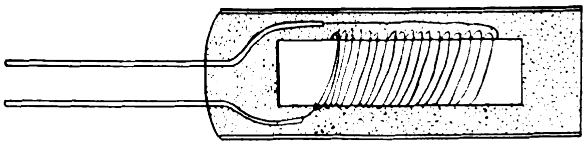

FIG. 5.—RESISTANCE COIL.

The known resistance is selected as nearly as possible equal to the unknown resistance to be measured; for instance, if we are measuring a series of field coil we know its resistance to be at most but a fraction of an ohm, consequently we should use the lowest resistance coil that we have, which in this case would be one ohm. Similarly, in measuring a shunt field coil whose resistance may be 16 or 20 ohms, we should use the ten ohm coil, and so on. The known resistance is connected across the binding posts at one end of the bridge, and the unknown resistance is similarly connected at the other. A source of e. m. f., two or three dry cells will answer, should be connected from *A* to *B*, The weight index is adjusted along the wire for a position where no deflection of the galvanometer occurs, and the point is read on the meter scale.

If a telephone is used instead of a galvanometer, it is best to interpose a key in the circuit, as shown in Fig. 2. The procedure is to then seek a point on the scale where the opening and closing of the key produces no click in the receiver.

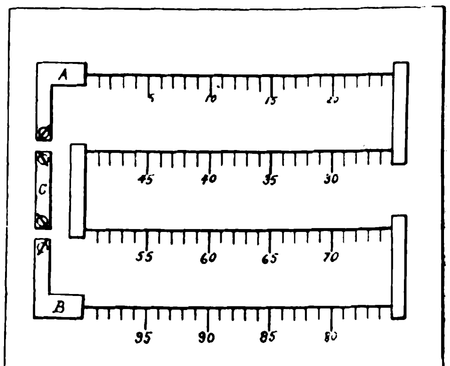

FIG. 6.—IMPROVED BRIDGE.

Multiply the known resistance by the length of the wire on the unknown side and divide it by the length of wire on the known side, and the result will be the value of the unknown resistance.

The bridge that has just been described is rather a clumsy construction, being nearly 4 ft. long, but it can be modified as follows, and the result will be more convenient:

A board 12 ft. x 14 ins. is provided with blocks of copper, as shown in Fig. 6. Four wires, each 25 centimeters long (about 10 ins.), should be soldered into them, as shown in the diagram, the blocks at the end being shaped as shown so as to be brought up conveniently near a third one. Assuming the blocks to be of negligible resistance, the wire must then be divided into four lengths of 25 scale divisions (one meter) each, and thus a more compact and satisfactory instrument will be obtained.

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LECTRICAL APPARATUS FOR AMUSEMENT—III.

THE SPIRITUALISTIC CASH BOX.

BY NEVIL MONROE HOPKINS.

Those familiar with the literature devoted to magic will doubtless recall the valuable experiments in the Black Art, conducted in Algeria by Robert Houdin, acting under a commission of the French Government. Charged with the suppression of the objectionable feats of magic and hypnotism, as carried on by the Marabout priests and Mohammedan miracle workers, the great French conjurer and magician set out, carrying such magical apparatus of his own invention best suited, in his keen forethought and judgment, to convince the Marabouts that a European could not only surpass their miraculous exhibitions, but expose their fraudulent occult demonstrations, with which they continually awed the more ignorant Arabs, and excited others to discontent and rebellion.

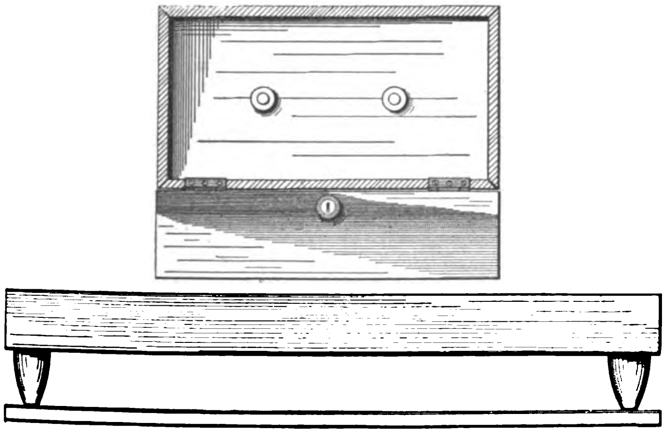

FIG. 1.—ELEVATION OF BOX AND PLATFORM.

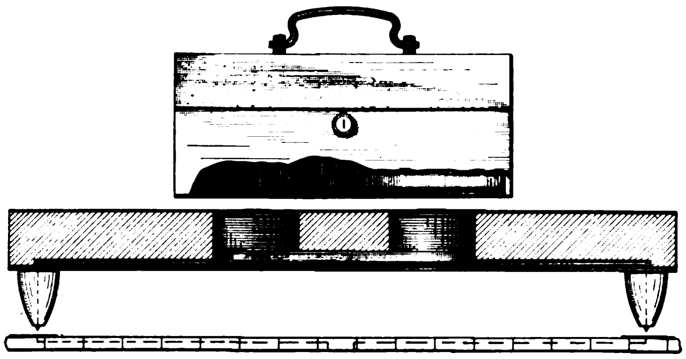

FIG. 3.—SECTION SHOWING ONE PAIR OF ELECTROMAGNETS.

Probably no other experiment had such success or such humiliating effect on the great priests as that performed by the aid of Houdin's greatest electrical trick, "The Light and Heavy Chest." Although this trick is referred to in a number of magical works the writer has never seen the mechanism of the box together with its secret pulleys and electro-magnets described, beyond a vague statement that the trick was dependent on electro-magnetism and trick pulleys. While the box designed and described by the writer probaby differs very radically from the historical one used in Algeria, it will be found extremely light, or extremely heavy, at the will of the operator.

Before describing the construction of the box and platform, the method of introducing and working the trick may not be altogether untimely. Fig. 1 shows the appearance of the writer's design of box, which includes a low "insulating" platform both of which may be closely observed by the spectators without the least fear of any telltale portion being discernible. After filling the box with beans, coin, cut paper or any handy objects or material asssociated with magical exhibitions, it is placed on the little platform and locked. A light rope is seen hanging from a couple of pulleys fixed to the ceiling, with which the box may be hauled up a few feet in the air. The performer having lifted the box a couple of feet or more from its platform, requests that some spectator take the end of the rope and hold the box in suspension. The performer now makes the usual mesmerical passes, and commands the box to increase gradually in weight, until it rests upon its little stand, or platform. The magician may have a couple of fingers under the handle of the box, and slowly lower his hand as the box descends, showing that he alone has the power of sustaining its weight and of arresting its rapid downfall.

The box once on the platform, the rope is untied or unhooked, and the person who was unable to resist its slow but sure descent is requested to stand on the platform and endeavor to lift it up independently of the rope and pulleys. He will be as unable to do this as he was to prevent the descent of the box, until equalizing mesmeric passes have been made by the performer, rendering the box as light as a small block of pine wood.

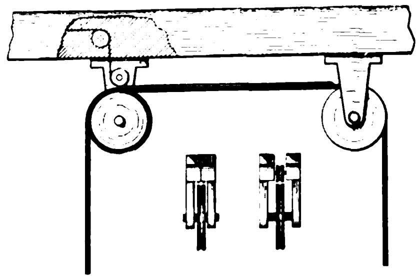

FIG. 2.—TRICK PULLEYS AND CORD.

By referring to Fig. 2, the pulleys, together with the secret wire, will be understood. The box is suspended from the left hand end of the hanging rope, and is pulled into the air from the end at the right. The fine, blackened steel wire passes through the supporting beam, over the small concealed pulleys, and is attached to the main rope as illustrated. To cause the box to increase in weight gradually, it is only necessary to suspend a large pail or other commodious receptacle from the end of the secret steel wire behind the scenes, and allow water or sand to slowly fill the same, when the pull, as will be seen, acts on the right-hand rope and taxes the strength of the person endeavoring to hold the box in suspension. Once on the platform, the double pair of electro-magnets are brought into play, making it next to impossible for the box to be lifted without the sanction of the performer.

Let us now take up the construction of the box and platform, together with the electromagnets, leaving the pulleys until the last. The present design represents the smallest box and magnets advisable to construct; in fact, the dimensions may be increased with advantage if the trick is to be shown to a number of persons on a stage. The box given here measures about 12 inches by 7 by 5, and is made from pine board ½ inch thick. An iron plate ⅜ inch in thickness is screwed on the bottom, and the whole given a coat of mahogany stain, making the whole appear as wood. The iron plate can to advantage be let into the bottom, in order that the sides of the box may cover the edges of the plate. A lock and key should be provided, as well as a neat brass handle. The base or platform is made from a piece of pine board 2 inches thick, and measuring about two feet by 12 inches. It must be provided with turned wooden legs, which raise the board about 2½ inches from the ground or stage upon which the trick is presented.

Fig. 3 shows the box partly cut away, allowing the iron bottom to be seen. The position of a pair of the magnets is also shown, together with the turned wooden legs, which are provided with sharp steel points, connected with the windings on the electro-magnets. These sharpened points prick through the carpeting on the stage and make contact with a couple of heavy copper plates, which have wires soldered to them, leading to the source of electrical energy and the controlling switch.

The electromagnets are fitted to the interior of this board or platform, by making four 3-in. augur holes or lathe cuttings, to receive the bobbins, with a couple of joining grooved channels chiseled out to receive the frame or bar of the magnets. Before doing this work, however, the magnets should be made and wound, the plan of construction being made clear by referring to Fig. 4. It will be seen trom the dimensions marked on the illustration that the 2-inch base-board will just take the magnets when they are carefully adjusted in the auger holes, with the grooved channels cut to the proper depth.

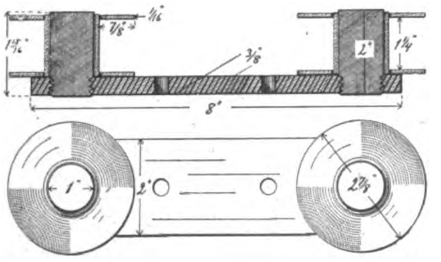

FIG. 4.—CORES, FRAME AND SPOOL SECTIONS OF A PAIR OF ELECTROMAGNETS.

Having made the magnet cores as shown the spools may be put together. These spools are made by soldering brass disks on thin brass tubing, which is slipped over the poles of the magnet core. These circular brass disks are quickly made by cutting out eight pieces of sheet brass 1-16 inch thick, to squares measuring a litttle over three inches. This can easily be accomplished by using tinner's shears, getting the squares as nearly equal as possible. They are now put together and soldered all around the edges in order to securely hold the lot from moving or slipping among themselves when the whole is chucked in the lathe, and the hole cut through the centre to receive the brass tubing. Having cut the hole through, the pack is removed from the lathe chuck and mounted on a lathe mandrel in order to cut the solder away and bring the plates down to true circles.

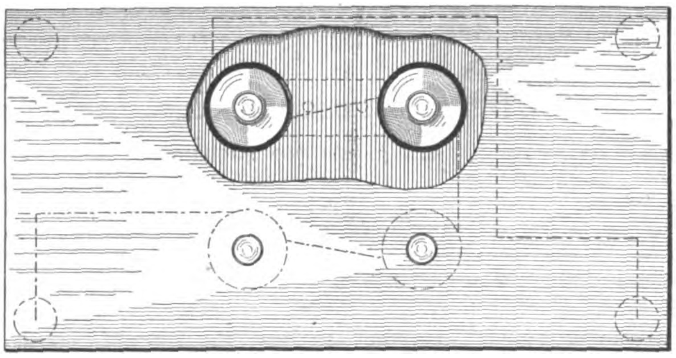

FIG. 5.—PLAN VIEW OF PLATFORM, SHOWING POSITION OF DOUBLE PAIR OF ELECTROMAGNETS.

Let us now wind these bobbins with double cotton-covered magnet wire of No. 18 guage after giving the inside of the brass spools six or eight coats of orange shellac, allowing each coat to thoroughly harden before the next coat is applied. Each spool must be wound full in even layers, a coat of shellac being applied to each layer as it is wound on. In order to wind the four spools full, and have a quantity of wire left for the electrical connections, four pounds of this No. 18 wire is required. Of course each pair of magnets must be wound for north and south poles, by reversing the convolutions of the wire on each bobbin, with the two pairs of magnets connected in series as shown by dotted lines in Fig. 5. This plan also shows clearly the position of the two pairs of magnets, designed to attract the iron bottom of the box on the four corners, each magnet pole taking one-fourth of the pull or strain put on the handle of the box. With this distribution of the magnet poles in relation to the handle of the box, which lies between them, it is impossible for a side strain or twist to concentrate its effect on any single pole, causing the bottom of the box to be disengaged from it.

Having completed the magnets they are pushed into the interior of the base-board or platform, and adjusted by shaving down the grooved channel, or by putting pieces of tin underneath, as the case may require, until the poles of the magnet project about 1-16 of an inch above the level of the platform. Having the adjustment perfect, the shank or bar of the magnet is screwed firmly in place by means of stout screws, and the holes shown in the bar illustrated in Fig. 4. The top of the base board is now covered with a piece of the thinnest wood, securely glued on, with circular holes accurately cut to allow the magnet poles to pass through. Walnut may be had of this extremely light weight, which may be planed down to meet the magnet poles after it is glued on, allowing them to protrude about 1-64 inch. The top is now completed, with the exception of paint or stain, a dark paint hiding absolutely the poles of the magnets if the work has been neatly done.

The bottom of the platform must have grooves cut with a gauge chisel to receive the wires from the magnet windings before a similar wooden bottom is glued on and painted to match the top. The turned legs are glued on the bottom and the proper wire connections made, preferably by soldering.

The magnets may be excited by a large plunge battery of eight or ten cells, or by connection with an incandescent electric lighting system through a bank of lamps arranged in multiple arc. If the service is of the usual 110-volt pressure, eight or ten lamps wired in multiple arc, and included in the circuit, allow sufficient current to pass for energetic excitation of the magnets.

The pulleys for carrying on the suspension part of the trick are too simple to require any detailed description. They may be turned from wood or metal, and be provided with either wood or metal blocks.

In exhibiting this box and stand, the performer elaborates on the fact that the little platform is purposely raised from the stage in order to allow a clear, unobstructed view under the box at all times, isolating it from all possible connection with devices under the stage. The spectator requested to lift the box, is, of course, made to stand on the platform after the running rope is united, his weight serving to press the points in the little legs to good contact with the copper plates under the carpeting.

Owing to the freedom with which it is possible to pick up the little platform at any stage of the trick and exhibit it as "an ordinary board," and the use of the pulleys and secret steel wire, theories as to the working of the trick are difficult to form, as in most tricks performed by bringing two methods into play differing in principle. Of course, a second pair of similar electromagnets can be set into the flooring of the stage to great advantage, in order to show that the little raised platform is merely an isolated stand, having nothing to do with the trick. By elaborating in this manner a most effective trick is sure to result.

DYNAMO TESTING.

TESTING FOR INDIVIDUAL LOSSES.

As mentioned in previous articles, the losses of the dynamo are separate and distinct, and each may be individually tested for and its magnitude determined. For convenience they are herewith re-enumerated. First, the wire losses consist of, *a*, field wire loss; *b*, armature losses; *c*, losses by eddy-currents. Second, iron losses, consisting of, *a*, hysteresis; *b*, eddy-current losses. Third, brush friction. Fourth, Bearing friction. Fifth, Wind resistance.

Some of these losses can be calculated at once, some vary with the load, some do not and some of them are almost inseparably combined together.

The C^2R losses can always better be calculated. The resistance of the armature and the field magnet should be measured when they are warm from continuous running. The currents in these parts at any particular load for which the value of these losses is desired should be measured, and the watt losses will be equal to the square of the current multiplied by the resistance it traverses. The resistance of the armature is usually very low, and can best be measured by means of what is known as the "fall of potential" method. To do this, disconnect the armature from the circuit and pass through it a strong current—the stronger the better—provided the carrying capacity of the armature is not exceeded. The armature should, of course, be at a standstill. Take the difference of potential at the brushes and divide it by the cur-

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rent in amperes for the resistance of the armature. The advantage of this method is that both the current and potential can be measured with considerable accuracy, whereas there would be difficulty in measuring a resistance of so low a value.

The field coil, if it be a low resistance series field coil, can be measured in a similar way, and the shunt field coil, in which the resistance is comparatively a large quantity, can be measured with precision by ordinary bridge methods.

The eddy-currents in the armature wire are usually very small indeed, and cannot be conveniently separated from the eddy-current losses in the other members of the machine. The losses due to eddy-currents are usually measured in bulk, together with iron loss due to hysteresis. This is done by driving the armature on open circuit in a fully excited field by a calibrated motor or similar convenient method of measuring the power. The difference in the power necessary to drive the motor thus, and that necessary to drive it with the field unexcited, is the losses due to eddy-currents and hysteresis. These two losses may be separated by making two experiments at different speeds. The eddy-current loss is proportional to the square of the speed. and the loss by hysteresis varies directly as the speed.

It is necessary to determine the combined eddy-current and hysteresis losses at two separate speeds. Call these speeds s_1 and s, call the total watt losses, due to eddy-current and hysteresis at each of the speed w_1 and w, respectively, and call the eddy-current and hysteresis losses at one revolution per minute x and y, respectively, it follows that

$$x s + y s^2 = w.$$
$$x s_1 + y s_1^2 = w_1.$$

This is a simultaneous equation, and from it the value of x and y can be computed in terms of w, w_1, s and s_1, all of which are known quantities. Their value will be found to be equal to

$$x = \frac{w s_1^2 - w_1 s^2}{s s_1 (s_1 - s)}. \quad y = \frac{w s_1 - w_1 s}{s s_1 (s - s_1)}.$$

From these formulas we may readily calculate the value of $x\ s$ and $y\ s^2$; if s is the standard speed, these quantities are the eddy-current and hysteresis losses desired.

The wind resistance of an armature is very slight if it is of a smooth, symmetrical type, and so small that it can hardly be measured. If the armature has a fanning action, such as is the case with the Brush arc machine or the Stanley-Kelly alternator, it may be sewed up in canvas and run with the fields unexcited and afterwards stripped and run again, the difference in the power necessary being the wind resistance of the armature. If the armature is of a plain, smooth body type, without spokes or other projections, which would tend to make the wind resistance a measurable quantity, it will be so difficult to measure these losses that errors involved will often exceed the quantity to be measured.

Bearing friction can be measured by measuring the power necessary to drive the dynamo at the commercial speed with unexcited field and lifted brushes. Bearing friction varies with the load, being sometimes greater and sometimes less when the load comes on, according to the pull of the field magnets upon the armature. There is no convenient way to determine it directly at full load.

It may, however, be estimated by subtracting from the gross input at full load the output and all the losses, excepting that of bearing friction, the other losses being calculated by the methods of the preceding paragraphs. It will be found instructive to compare the bearing friction at full load and at no load. As previously mentioned, the result may be almost anything, and the discrepancy may be so great that it will pay to shape the field magnets a little differently, so as to reduce the pull on the armature.

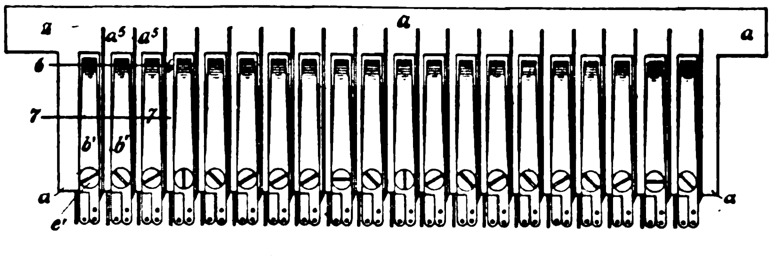
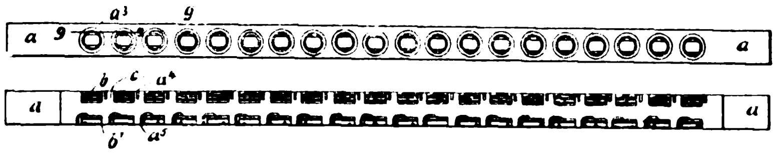


FIG. 1.—STRIP OF JACKS.

Brush friction may be conveniently determined by mounting the armature loosely in the centres of a lathe and mounting the brush holder with its supports upon a centre rest. Thus arranged, the armature is belted to a small calibrated motor, and the difference between the power necessary to drive it with the brushes lifted and that consumed when the brushes are down is the brush friction. Balancing the armature thus in the lathe centres makes the bearing friction almost nothing and very constant, thus enabling the brush friction to be measured with greater accuracy.



FIGS. 2 AND 3.—FRONT AND REAR VIEW OF JACKS.

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AMERICAN TELEPHONE PRACTICE.

SWITCHBOARD DETAILS.

BY KEMPSTER B. MILLER.

As has been pointed out in previous articles, success in practical telephone working can only be attained by the greatest attention to matters of detail. Nowhere is this fact better illustrated than in the design of the various parts which go to make up a multiple board. In the construction of large boards of this type, the possible capacity of the board is limited by the number of spring jacks which can be placed within the reach of a single operator. It is evident, therefore, that space must be economized to the last degree, and yet the jacks must be substantial in order to resist the wear and tear of years of service; must be made easily removable so as to be accessible for repairs; must perform their electrical functions with absolute certainty, and at the same time be so arranged as to facilitate the orderly and systematic connection of the wire leading from the line cables.

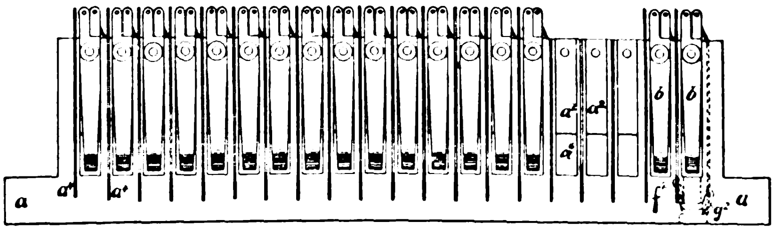


FIG. 4.—BOTTOM VIEW OF JACKS.

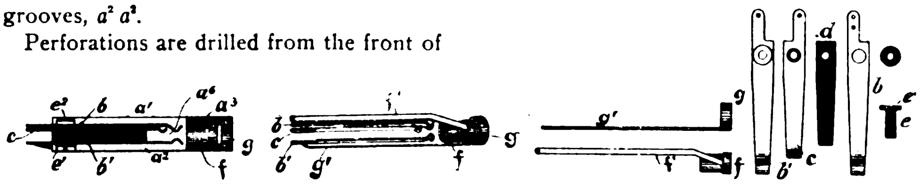
Moreover, when we consider that a multiple board and a capacity of 5000 subscribers will have in the neighborhood of 130,000 spring jacks, we can easily realize that the cost of producing these jacks must be seriously considered. It is well to state here, however, that any economy in the construction of a switchboard which will tend to decrease its durability and reliability of action is poor economy indeed.

As an illustration of modern spring jack construction, we will consider the spring jacks used in the branch terminal multiple board described in the preceding article. It has become common practice to mount the jacks in strips of twenty, and to so arrange each strip that it may be removed from the board by the removal of two screws, which bind it firmly to the frame work.

Fig. 1 shows a plan view of such a strip carrying twenty jacks. Fig. 2 is a front, and Fig. 3 a rear elevation of the same, while Fig. 4 is a bottom view. Fig. 5 is a vertical section through the centre of one of the jacks. Fig. 6 shows the metal portions of one jack assembled, and Fig. 7 shows the parts which, with the strip, *a*, go to make up a complete jack.

The hard rubber strip, *a*, forms the frame work for each strip of twenty jacks. The projections at its ends provide for attachment to the switchboard. In this strip are milled, on its upper side, the transverse grooves, a^1, a^1, and on its lower side similar grooves, a^2 a^2.

Perforations are drilled from the front of the strip, one perforation to each pair of grooves, having its axis centrally located and parallel with respect to the grooves. A small portion of the hard rubber is removed from between the grooves so as to leave a rectangular opening, a^6, shown in Figs. 4 and 5, through the strip connecting the two grooves at those ends which are nearer the front of the jack. In the grooves, a^1, upon the upper surface of the rubber strip are mounted springs, *b*, and *c*. The spring, *b*, is the longer of the two, so that its curved extremity is presented close to the end of the perforation through the front portion of the strip, *a*. The springs are insulated from each other by a strip or tongue, *d*, of hard rubber placed between them, thin and flexible enough to impede the flection of the two springs. In the under groove, a^2, is mounted another spring, b^1, similar to spring, *b*, and of equal length.



FIGS. 5, 6 AND 7.—DETAILS OF JACK.

The three springs, *b*, *c*, and b^1, are firmly secured to the strip, *a*, by a bolt, *e*, passing through them and the body of strip, *a*. The bolt is insulated from the springs, b^1, and, *c*, by rubber washers and bushings. In the perforations, a^8, in front of the strip, are inserted short tubes, *f*, of brass. Each tube or thimble, *f*, is provided with a shoulder, which bears against a corresponding ledge in the perforation, a^8, so as to prevent the tube from being thrust backward toward the rear of the jack by the insertion of the operators' plugs. The thimble, *f*, is provided with an extension, f^1, to afford electrical connection with it from the rear of the jack. This strip, f^1, extends through an oblique duct, f^2—shown in dotted lines in Fig. 4—and thence through a transverse slot or saw cut, a^4, to the rear of the strip.

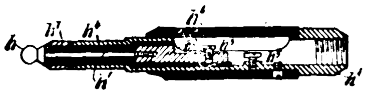


FIG. 8.—DETAIL OF PLUG.

In front of the thimbles, *f*, in the perforations, a^8, are placed the test rings, very short tubes of brass, *g*. These are forced into place against other ledges in the perforation. The ring, *g*, is also provided with an extension, g^1, projecting to the rear of the strip of spring jacks. These extensions, g^1, are of wire and pass through another duct, g^2, in the front portion of the strip, *a*, into a saw-cut, a^6, thence to the rear of the strip, where they are connected with the spring, *b*.

The springs in these jacks are of hard German silver, which has been found the most desirable material for this and similar purposes.

The detail of one of the plugs used with these jacks is shown in Fig. 8. The tip, *h*, of brass is secured by the rod, h^1, to the block, h^2, also of brass. Insulated from the tip portion by a rubber bushing is the sleeve contact, h^4, of the plug, which projects rearwardly and forms the main body of the plug. Over this portion is slipped a shell, h'', of hard rubber or fibre, which forms a handle for the plug. Between the tip and sleeve and insulated from each, is the ring, h^7, which, as was described before, is for short-circuiting the springs, *b*, and b^1, when the plug is inserted in the jack.

Screw connectors, h^3, and h^5, form convenient terminals for attaching the strands of the cord to the tip and sleeve, respectively, of the plug. These connectors are always readily accessible for inspection or repair by the removal of the sleeve, h^4.

This brings us to the subject of flexible cords for switchboard use. The matter seems at first thought to be a simple one, but much thought and time have been spent in perfecting this branch of the equipment. Even at this late day, the best cord is not good enough. As near a perfect cord as has up to the present time been made is constructed as follows: Each conductor in the cord is composed of strands of tinsel and a few fine copper wires, to add strength and conductivity. Around each of these conductors is wrapped tightly, in opposite directions, two layers of floss silk. These should be wrappings and not braids, as a wrapping serves to keep any broken ends of the tinsel or wire down in the bunch better than a braid. Around these wrappings of silk is a braid of linen, which adds strength to the conductor. If the cord be for a metallic circuit, the two conductors thus formed are then wrapped with two more layers of floss silk, and the whole is then encased in a strong spiral wrapping of hard spring brass wire. The wire in this spiral is stiff enough to retain its shape, but the spiral as a whole is so flexible as to allow free bending of the cord. An outer covering of polished linen is tightly braided over the spiral, and after the ends are tightly anchored to prevent the conductors sliding back and forth in the spiral, the cord is complete. An extra layer of outside linen braid is often put on the cord for a distance of about one foot back of the plug, to prevent the sharp bending or kinking of the cord by the operator in inserting the plugs into the jacks.

HANDY TOOLS IN POWER HOUSES.

A most frequent and annoying trouble in power houses is the cutting out of ordinary globe valves. If they are carelessly closed, the steam leaking through them, will cut the seats and the disks full of grooves, of which Fig. I is a fair representation. This renders them entirely useless unless they are again machined up true. Following is described a little machine which can be made at a small cost by any machinist and which will effectually reface grooved valve seats.

This, too, which is designed to operate in an ordinary bit stock, consists of a shank and is provided with the usual square shaped head adapted to be securely clasped by bit stock chucks. In the other end is drilled a rectangular hole, which will exactly fit two thicknesses of some standard tool steel, preferably 3-16 by 3-8. It is important that the sides of this hole toward the shank should be exactly flat and at right angles to the length of the tool, and that the hole should be very central.

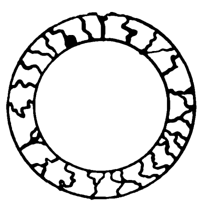


FIG. I.—SCORED VALVE SEAT.

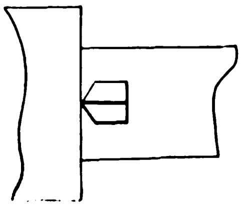


FIG. 2.—CUTTING TOOL.

The tool steel is prepared with a bevel edge, as shown to the right of the figure, and two such pieces are fitted into the hole so that they protrude at either end and form cutting edges. They are locked in position by means of a cup-shaped collar, which is secured to the end of the spindle, as shown, and is exactly the internal diameter of the valve seat to be refaced. It therefore follows that a number of these collars should be provided for various sizes of valves, but that the same spindle and cutting tools are adaptable to a number of sizes.

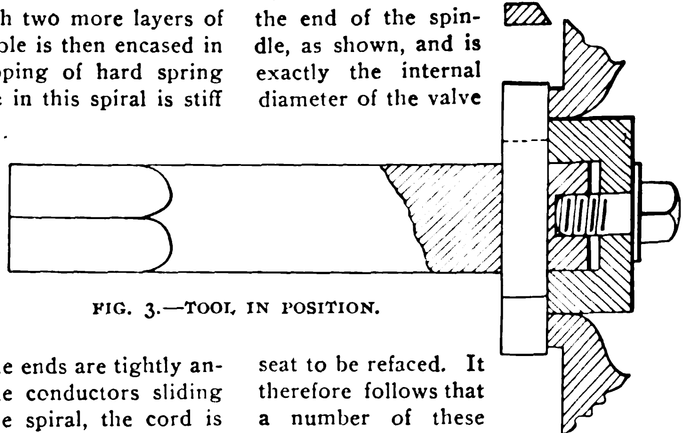


FIG. 3.—TOOL IN POSITION.

The method of procedure is obviously to fit tools into the shank, as shown in Fig.

2, when each of the two cutting edges will be central and opposite when viewed from one end of the hole, and therefore both of them will cut when the tool is turned. The tool is inserted into the valve seat as shown in Fig. 3, and rotated with considerable pressure by means of a bit stock. If skilfully done the valve seat will be bright, square and free from flaws after the operation is finished. Such a tool should not cost more than two or three dollars to build, and if the station attendant has a lathe at his disposal it is highly probable that with a little labor he can build the tool at even less cost. It will be found indispensable after it once has been tried.

◆

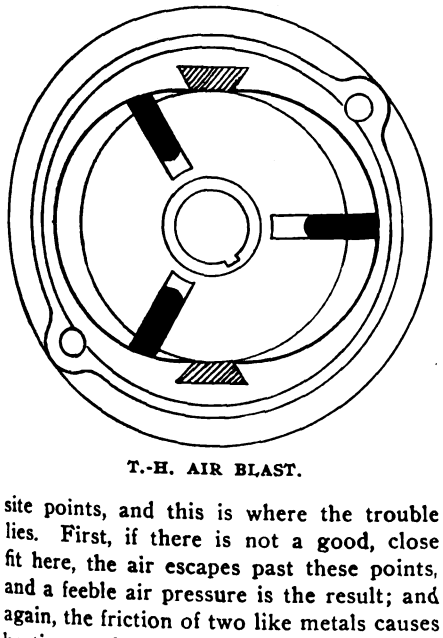
A REMEDY FOR TROUBLESOME ARC-MACHINE AIR BLASTS.

BY R. H. STERLING.

A weak feature of an otherwise excellent dynamo lies in the air blast of the Thomson-Houston arc machine. On the blast depends, more than all other causes, freedom from flashing; for, if there is not a powerful jet of air delivered to the brushes, flashing is almost sure to follow.

Then, again, a most fruitful source of heating lies in this selfsame piece of apparatus. These two defects—weak blast and heating—can be traced to one point, and the remedy is so simple and effective that I have found it advisable to apply the change in construction I am about to describe, to new air blasts that have not begun to show signs of wear.

It will be observed, on examining the interior of the blower, that the hub, or revolving part, touches the inner circumference of the case at two diametrically opposite points, and this is where the trouble lies. First, if there is not a good, close fit here, the air escapes past these points, and a feeble air pressure is the result; and again, the friction of two like metals causes heating and rapid wearing away of the parts. By referring to the accompanying diagram, showing the interior of the blower, there will be seen two dove-tailed pieces at the point of contact; these are segments of babbit metal, and are the simple devices that will relieve all the annoyance spoken of. The best way to insert them is as follows:



T.-H. AIR BLAST.

Remove both front and back plates, leaving nothing but the open ring of the case, and make two dove-tailed slots by filing, or better still, cutting in a planer (for the cast steel is difficult to file), and have them the same width as the space the hub revolves in and one-half inch thick. Now replace the back plate, lay the case face up, and place the hub in position and exactly in the centre, first pasting a piece of letter paper around the circumference of the hub. With some putty dam up any openings left at the edges of the slots, and place pieces of heavy cardboard, weighted down, on top of the slots, having two holes in each—one to pour the melted babbit through, and the other to allow the air to escape. The object of the cardboard is to form a level surface on the babbit.

It is best to have the blower case and hub warmed first, so that the babbit will not be chilled too quickly, which will allow it to flow at a thinner state and make a better cast. When cooled off, remove the hub and scrape smooth the surface of the babbit where the hub revolves. The thickness of the writing paper allows for enough clearance. See that the babbit has filled up flush with the face of the case under the cardboard, so no air can escape there.

After two years' trial of one of these remodeled blowers on an all-night machine, it has not been known to warm up, even in the warmest nights in summer, and the blast is as sharp as when first started. Furthermore, there seems to be no wear to the hard rubber wings, and a less amount of oil is required.

◆

INTERIOR WIRING.

SYSTEMS AND METHODS OF WIRING.

BY CHARLES E. KNOX.

In adopting the system and selecting the method of wiring, we are generally aided or (in some cases) hindered by the existing conditions. If current is obtained from an outside source, and there be little probability of an isolated plant being installed in the building, it simply remains to have the wiring comply with the requirements of that system. In some cases there may be two outside sources of supply; in this case it is frequently desirable to have the wiring adapted for use with either system, in the interest of the consumer.

If, on the other hand, a dynamo plant is to form a part of the installation, the problem becomes somewhat more complicated. In some cases (usually in large plants) it is reasonably certain that the plant in the building will be the sole source of current. As alternating current machines are rarely employed in isolated plants in buildings, the wiring in these cases would be the two-wire system for direct current. If, however, it is desired to supplement the plant with, or to have as an extra precaution in case of break-down, an outside source of supply, the wiring must be adapted for use with either or both systems.

If the outside source is the three-wire system, it is usually the practice to run three-wire mains and feeders, making the middle conductor of twice the cross-section of the two outside conductors, and having a triple-pole "breakdown" switch on the switchboard, so connected that, when the switch is thrown one way, the current is supplied from the plant in the house, the two outside conductors being connected together; when the switch is thrown the other way, the current is obtained from the outside source, the middle conductor becoming the neutral wire, one outside becoming positive and the other negative.

Another way of accomplishing the same result is to run two-wire feeders and mains, using double-throw feeder switches, so connected that when the current is obtained from the outside service, the load may be distributed equally (or nearly so) on the two "legs" of the system, by throwing the various switches one way or the other until a balance is obtained. We will discuss the comparative merits of these two methods later on in the series.

If the outside supply be alternating current, and it be used in conjunction with the plant, or if it is the sole source of supply, no radical change need be made in the wiring unless iron or steel armored conduit be used. In this event it is absolutely imperative that the two wires constituting any given branch circuit feeder or main be placed in one tube. For, if the two wires of any circuit were placed in separate tubes, we would have practically a single turn of conductor around an iron core (the core being the walls of the iron pipe), the result of which would be that a counter E. M. F. of self-induction would be created, and eddy-currents would be set up in the iron. The disturbance thus produced is proportional to the frequency of the alternations and the current flowing through the conductor.

The writer knows of one instance where this fact was overlooked by all parties concerned in quite a good-sized office building, where alternating current was to be used, and in every case the two conductors, constituting a feeder or main, were run in separate tubes. When the current was turned on, the E. M. F. was cut down to such an extent that it was barely sufficient to make the lamps red. The result was that the feeder and main circuit wire had to be pulled out of the tubes and run exposed on the walls and ceiling in moulding. Even if iron or steel tubes be not used, it is necessary to keep the wires as close together as possible, as the inductive E. M. F. depends upon the number of line of force inclosed by the loop, the area of which increases, of course, with the distance apart of the two conductors.

If a plant is to be installed as a part of the equipment, the voltage of the installation may be made to fit the requirements. At the present time, for incandescent lighting, the choice of voltage lies between the 110 and 220 volt systems, the selection of one or the other being dependent on whether 110 or 220 volt lamps be used.

While it is doubtless true that the latter voltage will in time largely, if not entirely, supersede the former, the selection and use of the higher system should be attended with the utmost care. The reason that this precaution is necessary is due to the small factor of safety usually allowed in the manufacture of electrical specialties. All the standard sockets, rosettes, receptacles, panel boards and switches are designed for 110 volts, and they have "troubles of their own" even at that voltage. To increase the voltage with these same appliances is simply increasing the possibility of defects in the installation. Of course, there may be existing appliances here and there which may have been designed with a sufficient margin for using them on 220-volt circuits, but each socket, rosette, etc., should be examined with regard to its availability for that voltage. Then, too, the wiremen will have to become accustomed to the higher voltage, so that they will exercise greater care in making connections at the outlets, fixtures and panel boards.

As to the method of running the circuit work, this is also usually determined by attending circumstances. If the building is a new one, it is rarely either desirable or necessary to expose the work. If the circuit work is concealed, it is necessary to place the wires in conduits. It is poor economy nowadays to use any conduit other than an iron or steel tube with a suitable insulating lining. The "best is none too good" and this best is neither too good nor too expensive, so there is really no excuse for not using it. Brass conduit is still largely used in installations outside of the great cities, but with this tube so many precautions must be taken to prevent its destruction by the traffic incident to the construction of a building of any size, by the nails of the carpenter in laying the floor, and also by the action of the cement on the copper in the tube, that it is questionable whether there is any actual saving between the cost of it and of the iron tube. The estimated difference in cost between the use of brass and iron-armored tube is probably between 10 and 20 per cent. To use any existing conduit other than those having iron, steel or brass armor, where it is possible to use these, would be a short-sighted policy.

In buildings already built, and, indeed, sometimes in new buildings, it is both preferable and essential to run the work "exposed." There are three ways of insulating the wiring generally employed in this class of work. The wires may be run: first, in moulding; second, in conduit; third, supported on porcelain cleats or insulators.

The advantages of the use of moulding are obvious. It is cheap, easily and quickly put up, unobtrusive and is flexible in the sense that it readily accommodates itself to varying conditions. Its disadvantages are: that it is rarely if ever fireproof, the capping is frequently removed after the work is done, allowing the wires to hang down, and it is not nailproof; in fact, when it is run along the wall, it presents a splendid means of support for coat hooks, picture frames, etc. There are cases where it is wise to use it, however, simply and solely because it is better than anything else we now have to replace it.

Conduits are rarely available for exposed work, because they are generally unsightly, expensive, difficult to put up and because of the number of bends and elbows usualy necessary in crossing beams and to avoid other exposed work. For the rising portions of the feeders and mains, and for the portions run in the cellar and other places where it is not objectionable on account of its appearance, it is to be preferred to either of the other two methods.

Running the wiring on porcelain insulators or cleats has one overwhelming advantage over either of the other methods, which is that the defects in the wiring, where there are any, are plainly visible, and for this reason the wiring is usually put up with great care, and the defects are few in number: like moulding, it is also cheap, easily and quickly put up and has a certain amount of flexibility.

In some instances it may be desirable to use all three methods, each being most suitable for some particular portion of the building. In fact, sometimes it is even wise to use flexible tubing, "fishing" it between the floors and the ceilings where there is sufficient space, running up between "studs" in the partitions and by other similar methods. This is very likely to be the case in a building already built, no provision having been made for electric light, the walls and ceilings being expensively decorated and parquet floors laid. In such instances cutting the walls and ceiling or taking up the floors would not be permissible. When the building has been built for several years, and has thoroughly dried out, and if great care be exercised in the installation of the work, a fairly safe and satisfactory piece of work may be accomplished in this manner.

* * *

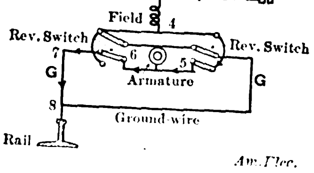
ELECTRIC RAILWAY PRACTICE.

BY EUGENE C. PARHAM.

INSTALLATION.

In our last complete article under this caption we considered the placing of the several devices which comprise a car equipment, and left off where the devices were temporarily connected to the hose. We will now cite some of the commoner difficulties incidental to starting a car on its initial trip, and give the methods of locating them.

The temporary connections between hose and devices being made, the next step is to see that both controller handle and reverse handle, or drum on both controllers, are at the "off" position; then, putting on the trolley and closing both hood switches, "give 'er a notch," to see if the motors conspire to run the car in the same direction; and if in the same direction, in accordance with the reverse handle indication on both ends of the car. It is undesirable to have the reverse switch on one end of the car direct the car north and the reverse switch on the other end direct the car south, for, as can be seen in Fig. 1—a symbolical drawing involving a single motor controlled from both ends by means of two reverse switches and two ordinary rheostats—the result will be a short circuit, as through path 1, 2, 3, 4, 5, 6, 7, 8. As soon as the rheostat is pretty well cut out, the car fuse blows if the motor field does not.



Am. Elec.

FIG. 1.—CAR CIRCUITS.

Before we proceed further, let me say that many railway men agree with me that the customary method of connecting the motors to the hose by means of ordinary two-way connectors sewed with tape is awkward and expensive. Occasions often arise for raising the car body from the truck, necessitating disconnection of the motor and loss of time and tape. This loss is a small matter on a single equipment, but when we consider the case of a dozen or more trucks to be shifted from summer to winter, and from winter to summer cars, year in and year out, besides the number of times it may be necessary to disconnect the motors for testing or repairing, the desirability of improvement presents itself more forcibly.

If upon giving the controller a notch the car fails to move, any one of several conditions may be responsible. If upon throwing off no flash is observed, it shows that the car is taking no current, and that, therefore, there is want of power on the line, or that there is either an open circuit or—what may amount to the same thing—a wrong connection. Sometimes failure to move is traced to a very trivial cause, such as the trolley being tied down, or resting on a circuit breaker, or a hood switch left open or no brushes in the motors. Absence of power may be due to temporary trouble at the power house or to neglect in closing a local switch.

A difficulty commonly contended with is a "dead" or dirty rail. In the first case, the rails upon which the car wheels rest are not bonded to abutting rails; in the second case, dirt on the rail, however well bonded, insulates the flat surface of the wheel tread so no current can pass. In either case a man standing on good ground and touching the truck, dash rail or grab handle, and in wet weather even the car side, is liable to have his ideas confused. In case of a "dead" rail a wire must be run from the "dead" rails to the live ones. The troubles due to dirty rails can be generally removed by laying a switch iron or crowbar on the rail and pinching the wheel. The operator must be very careful to get the iron well on the rail before touching the wheel or the current will ground through him, ordinary earth being absolutely useless as a conductor of large currents, but a good shock medium.

If the car lamps burn all right, it shows the trouble to lay between the positive side of the first hood switch and the rail. If the car lamps fail to burn (assuming their circuit to be intact), and the test lamps, described in a previous article, burn all right, when one end of their circuit is attached to the trolley wire and the other end to what is known to be good ground, the fault may be located as follows:

Leaving the test circuit's ground end secure, and the trolley wheel on the wire, close both hood switches, and with the trolley end of the test circuit touch successively the wire, wheels, hasp, stand, positive and negative side of both switches, and finally the controller trolley connecting post; if the lamps continue to respond up to and including the last-named point touched, it indicates the wiring to be intact between the trolley wire and controller. If at any test the lamps fail to glow upon making good contact with a given point under test, it shows the open circuit to lay between the point of failure and the preceding point touched, and this part of the circuit must be investigated.

The next step is to test the circuit from the rail to the controller ground connecting post. Leaving the trolley test line attached to the trolley wire, the other test line is touched, first to good ground, to insure that the test circuit is in good order, and is then touched successively to the rails on which the wheels rest, an unpainted part of the truck, a bolt head on the motor frame, the terminal connecting the motor frame to the ground wire, and at last to the controller ground connecting post. Just as before, any two points on one of which the lamps glow, and on the other of which they do not, include the open circuit.

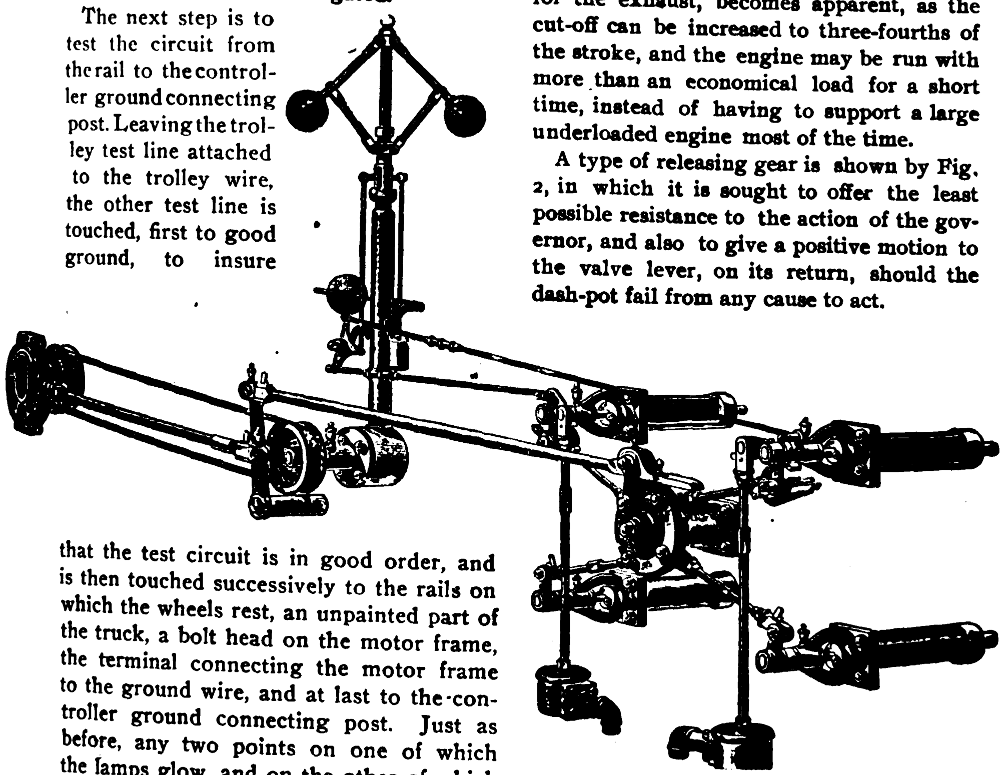


FIG. 1.—A TYPICAL CORLISS-VALVE GEAR.

We have thus far, with the exception of several wires inside the controller, gone over all wires which carry the current of both motors under all conditions, and in doing so we have shown that the trouble must be included between the trolley and ground controller connecting posts. To proceed with the test, some knowledge of the car wiring is required, and this will be considered in the succeeding article.

VALVE GEARS.

Undoubtedly, the Corliss-valve gear has done more to improve the efficiency of the steam engine than has any other gear. It must be acknowledged, however, that some less complicated gears are doing almost, if not quite as much, in this line as are the complicated forms of Corliss gears, a type of which is shown by Fig. 1. It is claimed by the makers that the simple little gear shown by Fig. 3, of the preceding article, does everything, and secures all the efficiency commanded by the elaborate Corliss gear of Fig. 1.

But there are a great many forms of "Corliss valve" now on the market, the varieties being almost as numerous as the makers thereof. Some forms have one wrist-plate, as seen in the engraving, other forms have two wrist-plates, and still others have the two eccentrics, but no wrist-plate at all. The methods devised for detaching the valve from the rod whenever the cylinder has taken sufficient steam for that stroke, are also very many, and a few of them will be described here.

When the engine is to be driven all the time with a stated load which varies very little, then the single eccentric, one-wrist-plate variety leaves little to be desired; but when the work is to vary through a wide range, as when driving street railways and rolling mills, then the value of one eccentric for steam admission, and another eccentric for the exhaust, becomes apparent, as the cut-off can be increased to three-fourths of the stroke, and the engine may be run with more than an economical load for a short time, instead of having to support a large underloaded engine most of the time.

A type of releasing gear is shown by Fig. 2, in which it is sought to offer the least possible resistance to the action of the governor, and also to give a positive motion to the valve lever, on its return, should the dash-pot fail from any cause to act.

A is the valve-lever, keyed upon the valve stem, *B*; *C* is the tripping-lever, carried upon the fulcrum pin, *D*, on the lever, *A*; *E* is tripping-lever pin on trip-lever, *C*; *G* is valve-connecting rod connecting tripping-lever pin, *E*, to wrist-plate pin; *H* is latch-lever hung on stud-pin, *L*, on valve-lever, *A*; *I* is a roller carried in joint of latch-lever upon stop-pin; *N* is a spring pressing stop-pin against valve-lever, *A*; *O* is a valve-stem bearing, shown broken, and forming part of steam chest cover; *P* is a reverse catch bar attached to tripping-lever *C*; *Q* is a dash-pot lever.

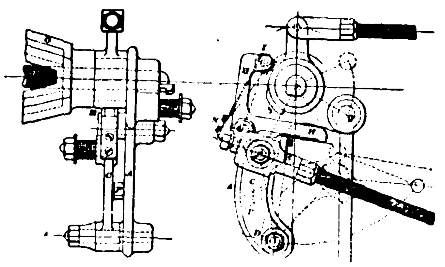


FIG. 2.—CORLISS-RELEASE GEAR.

In operating this releasing gear, when the parts are in the position as shown in Fig. 2, with the latch securing the tripping-lever, the movement of the wrist-plate by means of the connections causes the valve to be opened, and, according to the position the governor lever cam, *I*, is set in it, will determine, in relation to the speed of the governor, the point at which the latch-lever will be released.

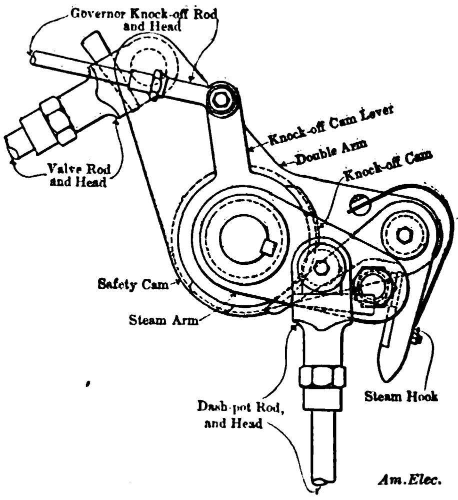


FIG. 3.—RELEASE WITH SAFETY CAM.

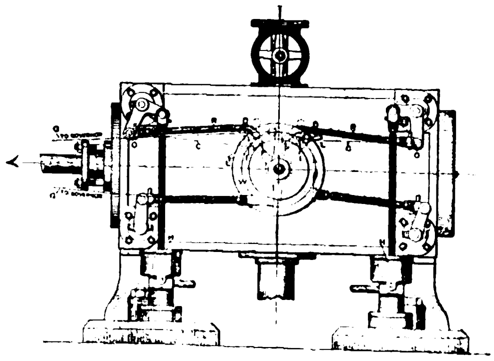


FIG 4.—WRIST-PLATE RELEASE.

It will be noticed that the inner corner of the latch on latch lever where it engages the toe of the tripping-lever, is in a direct line with the center of the pin, *L*, upon which the latch-lever is hung, so that the holding part of the latch is confined to a line central with the pin when the movement of the wrist-plate is transmitted to the tripping-lever, which is held by the latch-lever.

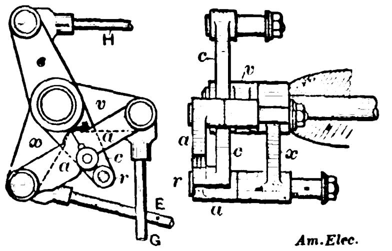


FIG. 5.—COLLAPSING RELEASE.

The slightest contact of the roller on the latch-lever with the governor lever cam disturbs this narrow line of pressure, and the further movement of the tripping-lever, causes the latch jaw to move upward and away from the toe of the tripping-lever, thus taking the strain off of the roller of the governor cam, and allowing the governor to act freely.

The further movement of the toe of the tripping-lever causes it to travel in a curve the reverse of the curve on which its fulcrum on the valve-lever travels. Thus all drag or friction which is common to tripping-levers which work around the center of the valve-stem, is avoided, and the evils incidental to that system of liberating gear are got rid of.

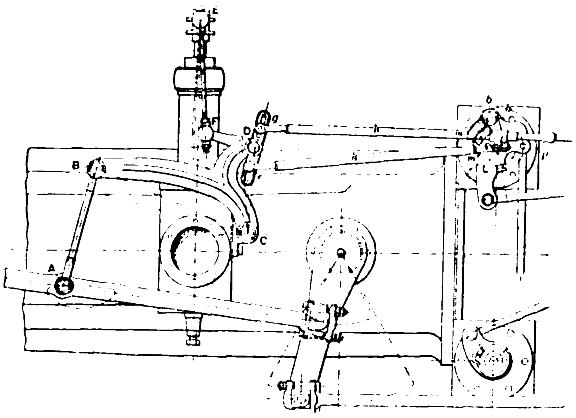


FIG. 6.—RELEASE FOR LONG CUT-OFF.

Another form of releasing gear is shown by Fig. 3, where a safety cam is attached to the bottom of the knock-off cam, in such a manner that should the governor belt break, or the governor be stopped by accident, the engine will be stopped at once. The simplicity of the gear is also clearly shown by the engraving.

Another gear is the one marked Fig. 4. In this, all steel blocks, springs, hooks and small parts have been eliminated, and the release gear is attached direct to the wrist-plate, nothing but a simple folding device being used. This makes the valve motion practically noiseless.

The operation is as follows: The wrist-plate, *W*, moving in the direction indicated by the arrow, would cause link, *L*, to tighten and keep its hold on valve rod, *R*, until the end of link, *L*, comes in contact with roller, *D*, at which point the center of pin, *P*, is raised above center line, *C*, allowing the dash-pot to instantly close steam valve, the link assuming similar position to that shown on the left hand. When the wrist-plate completes its motion in direction indicated, the left-hand link, *L*, and rod, *R*, will fold together like that on the right side.

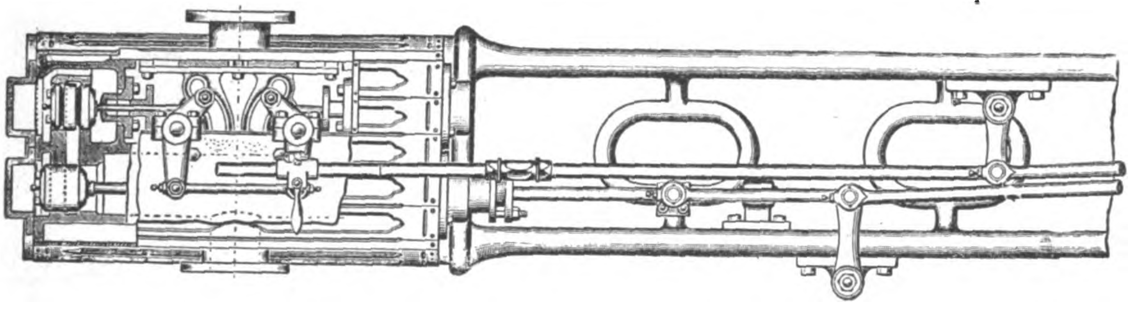


FIG. 7.—PISTON-DETACHING GEAR.

Another form of folding, or rather of collapsing gear, is that in Fig. 5, whereby the steam arm is held to the valve rod by means of a sort of knuckle joint, which doubles up at the end of the travel, or when affected by the governor rod, and allows the dash-pots to assume control of the admission valves.

Another form of Corliss gear (Fig. 6) is for securing the effect of the double eccentric, and thereby allowing the engine to work under overloads up to a cut-off of 75 per cent. or even more. The gear is a complicated one, and it is a question whether the double eccentric is not the most advisable form. Other forms of valve gear dispense with the wrist-plate and the unhooking devices. The same eccentric motion is used as with the Corliss, and in some cases, the same form of valves, a sliding block being used instead of the wrist-plates and releasing hooks.

In Fig. 7 a gear with four piston valves is shown, two eccentrics being used, and the steam valves controlled independent of the exhaust. This is a form of piston-valve gear where there is an unhooking device, allowing the valves to be controlled by hand at will.

One other gear must receive notice in this article. It is a double-eccentric device, with a differential attachment whereby the admission valve partakes of the same motion given to the exhaust valves, but is modified by the second eccentric, which in turn is controlled by a wheel governor. The three large diagrams show the action of the device very plainly. The small diagram delineates the geometrical movements of the several parts; as seen in the center of Fig. 8.

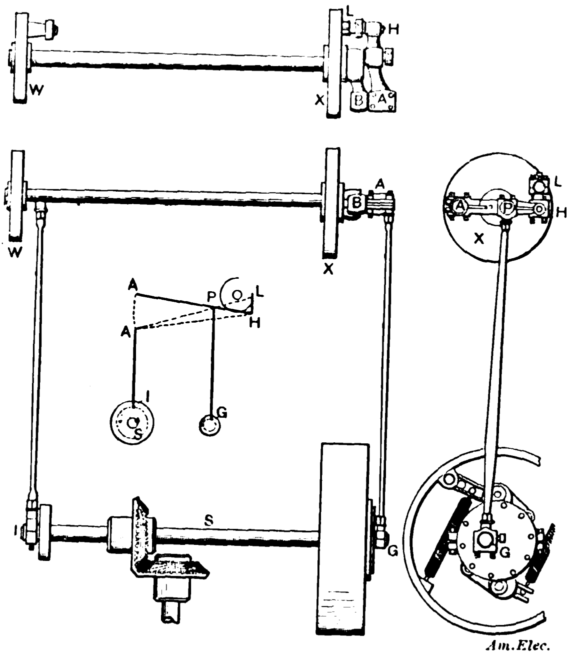


FIG. 8.—DIFFERENTIAL, DOUBLE-ECCENTRIC GEAR.

In some cases, particularly in compound engines, the rods, instead of being attached directly to separate valves, are carried to wrist-plates and all the valves of a compound or triple expansion engine are worked therefrom. In such a case, there would be two wrist-plates, one for the steam, the other for the exhaust valves.

LESSONS IN PRACTICAL ELECTRICITY

INDUCTANCE AND CAPACITY IN PARALLEL.

In the preceding article the subject of inductance and capacity in series was considered, and in the present one their arrangement in parallel will be taken up. To some readers the calculations may appear somewhat complex, but they have been made as simple as the subject admits. No knowledge beyond arithmetic and the use of formulas is actually necessary, as the trigonometrical calculations have been reduced to the solution of right-angled triangles and a formula.

The subject, in fact, is one very difficult to simplify from its very nature. When treated analytically or in a general manner, a considerable mathematical education is required, while graphical solutions are so involved as to be usually unintelligible to few besides those who construct the diagrams.

The reader who wishes to make calculations similar to those given here should have a table of sines and tangents, which are usually found in mechanical handbooks. To use such tables in the present instance requires no knowledge of trigonometry, as they only serve to identify angles, or vice versa.

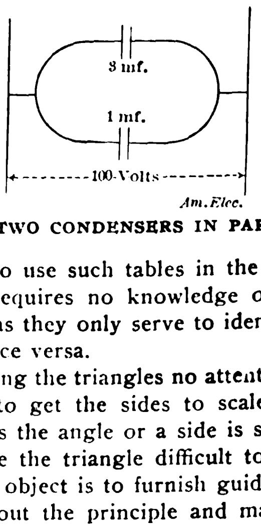


FIG. 1.—TWO CONDENSERS IN PARALLEL.

In drawing the triangles no attention will be given to get the sides to scale, as in many cases the angle or a side is so small as to make the triangle difficult to represent. The object is to furnish guidance in following out the principle and make the solution as mechanical as possible. The three triangles used will be distinguished

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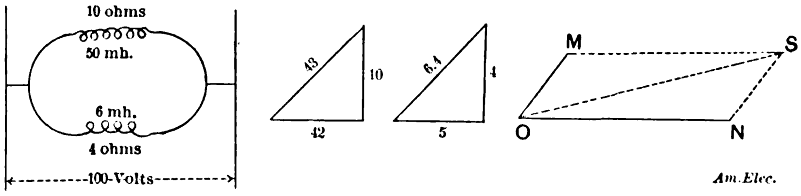
as inductive, capacity and current triangles, respectively.

Referring to Fig. 1, suppose that across a 110-volt alternating current circuit having a frequency of 133, two condensers are placed in parallel, one having a capacity of 3 microfarads and the other of 1 microfarad.



FIGS. 2, 3, 4 AND 5.—TWO INDUCTANCES IN PARALLEL.

In a preceding article the deduction was given of the formula for calculating the E. M. F. set up at the terminals of a condenser in a circuit through which current is flowing, the formula being

$$E = \frac{1000000\, C}{2\, \pi\, n\, k\, E}; \qquad (1)$$

solving this for $E = 100$, $n = 133$ and $k = 3$, we find that the value of the current in the three-microfarad condenser circuit will be

$$C = \frac{2 \times 3.1416 \times 133 \times 3 \times 100}{1000000} = .2507.$$

As the capacity of the other condenser is one-third that just calculated, the value of the current in its circuit will be .083. As these two currents will be in phase with each other, the current flowing in conductor *A B** will be their sum, or .3337 amps.

Taking up now the case of two inductances in parallel, suppose, as in Fig. 2, one of the parallel branches has an inductance of the value of 50 millihenrys and a resistance of 10 ohms; and the other an inductance of the value of 6 millihenrys and a resistance of 4 ohms; substituting in the formula for inductive E. M. F. deduced in the preceding article

$$E = \frac{2\, \pi\, n\, L\, C}{1000} \qquad (2)$$

we have in the case of the upper branch for $C = 1$, $n = 133$ and $L = 50$,

$$E = \frac{2 \times 3.1416 \times 133 \times 50 \times 1}{1000} = 42$$

or 42 volts inductive E. M. F. when a current of 1 amp. passes.

Referring now to the inductive triangle, Fig. 3, the length of the base, which represents the inductive E. M. F., will be 42. As 1 amp. is flowing, there will be 10 ohms ohmic drop in the coil, which will be the perpendicular of the triangle. Solving the triangle, we find that its hypothenuse will be 43, which will represent the impressed E. M. F. Since, however, the E. M. F. between the mains is 100 volts, the current flowing will be in the ratio of 100 : 43 or 2.32 amps.

Proceeding as above, it will be found that the inductive E. M. F. corresponding to 1 amp. flowing through an inductance of 6 millihenrys is 5 volts, and the ohmic drop from 1 amp. through 4 ohms is 4 volts. Referring to the triangle of Fig. 4, this gives an impressed E. M. F. of 6.4 volts. Since, however, the E. M. F. between the mains is 100 volts the current flowing will be in the ratio of 100 : 6.4 or 15.6 amps.

As will be seen from the triangles, Fig. 3 and Fig. 4, the two currents will not be in phase since the angles between the perpendicular and hypothenuse are different. The tangent of the angle is in each case the base divided by the perpendicular, or 4.2 for the triangle of Fig. 3 and 1.25 for the triangle of Fig. 4. Referring to a table of tangents, it will be found that these correspond to angles of 76 deg. and 51 deg. respectively.

In other words, since the current is in phase with the ohmic E. M. F. or the perpendicular of the triangle, in one case the angle between the impressed E. M. F. and current of 76 deg. and in the other 51 degs., or the currents have a phase difference of 76-51, or 25 degs. What we now require to know is the resultant of these two currents which will give the current flowing in the conductor, *A B*.

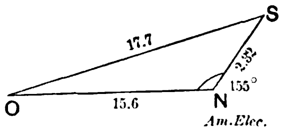
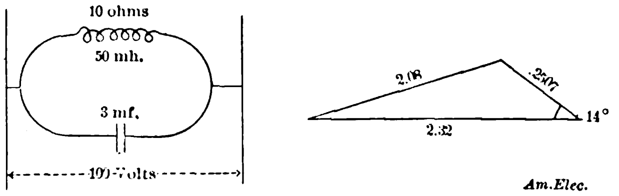


FIG. 6.—CURRENT TRIANGLE.



FIGS. 7 AND 8.—INDUCTANCE AND CAPACITY IN PARALLEL.

Fig. 5 represents a parallelogram of forces, of which the two sides represent in length the values of the two currents above found, while the angle, *M O N*, represents the phase difference of the currents; therefore, the diagonal, *O S*, will represent the value of the current flowing in the circuit. It will also be seen that instead of drawing the parallelogram we might have laid down the lines corresponding to the value of the currents, at an angle equal to the supplement of the phase angle, or the difference between 180 degs. and that angle—155 degs. in this case. This gives us a simple triangle, as in Fig. 6, of which the unknown side is the resultant whose value we wish to know. This triangle may either be laid down by means of a protractor and the side, *O S*, measured, or the triangle may be solved trigonometrically.* In either case it will be found that the length of the line, *O S*, is 17.7, which gives the value of the current that will flow through, *A B*.

It will be seen that this current is greater than either of the component currents and less than their sum. With two inductances in parallel the current will always be less than the sum of the component currents, except in the limiting case, and the angle, *O N S*, of the current triangle will always be obtuse.

Fig. 7 represents the case of an inductance and a capacity in parallel. The value of the inductance is 50 millihenrys and its resistance 10 ohms, the value of the capacity being 3 microfarads.

We found in the first case considered that the current flowing under an impressed E. M. F. of 100 volts through a condenser of 3 microfarads is .2507 amp., and in the second case that the current flowing under the same impressed E. M. F. through an inductance of 50 millihenrys and 10 ohms is 2.32 amps., the angle of inductive lag being 76 degs. But the current flowing through the condenser leads the E. M. F. by 90 degs., so that the two currents have a difference of phase of 90 + 76 = 166 degs.

Instead of drawing the parallelogram of forces, as in the second case, in order to find the resultant current, we may use a simple triangle under the condition that instead of the angle of phase difference, its supplement be used, which in this case is 180 — 156 = 14 degs. (Fig. 8). Solving this triangle as explained in the footnote, we find the resultant current to be 2.08 amps.

That is, the current in the conductor, *A B*, is actually less than the sum of the two currents in the parallel circuits. This follows from the fact that, owing to the difference in phase between the parallel branches, a current surges back and forth between them. A practical application of this peculiar phenomenon is that with a given E. M. F. a greater current may be passed through an inductive circuit by shunting it with a condenser; and there is one value of a condenser capacity that will entirely nullify the inductive E. M. F., as in the case of an inductance and capacity in series.

Fig. 9 represents the case of a branch having in circuit a condenser of 5 microfarads in series with a 50-volt lamp, the

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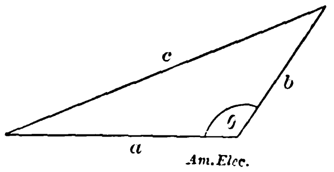
**A B*, omitted by the engraver, designates here and following the conductors connecting the parallel circuit to the line.

* The triangles used in these problems other than right-angled triangles may all be solved by the following formula:

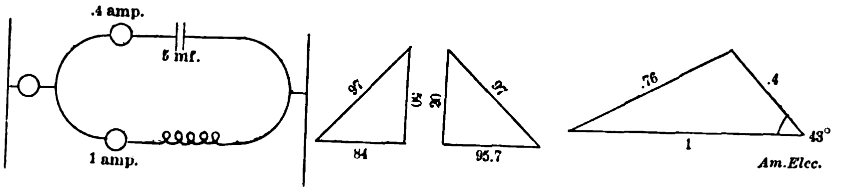
$$c^2 = a^2 + b^2 - 2\, a\, b \cos \theta$$

in which the letters correspond to the sides of a triangle, as shown in the accompanying cut, *c* being the unknown side. When, however, the angle is more than a right angle, the negative sign become plus. For example, in the above case, $a = 2.32$; $b = 15.6$ and $\theta = 155$ deg. The cosine of 155 deg. is .906 (sign being neglected). Therefore $C^2 = 5.38 + 243 + 2 \times 2.32 \times 15.6 \times .906 = 314$, or $C = 17.7$.



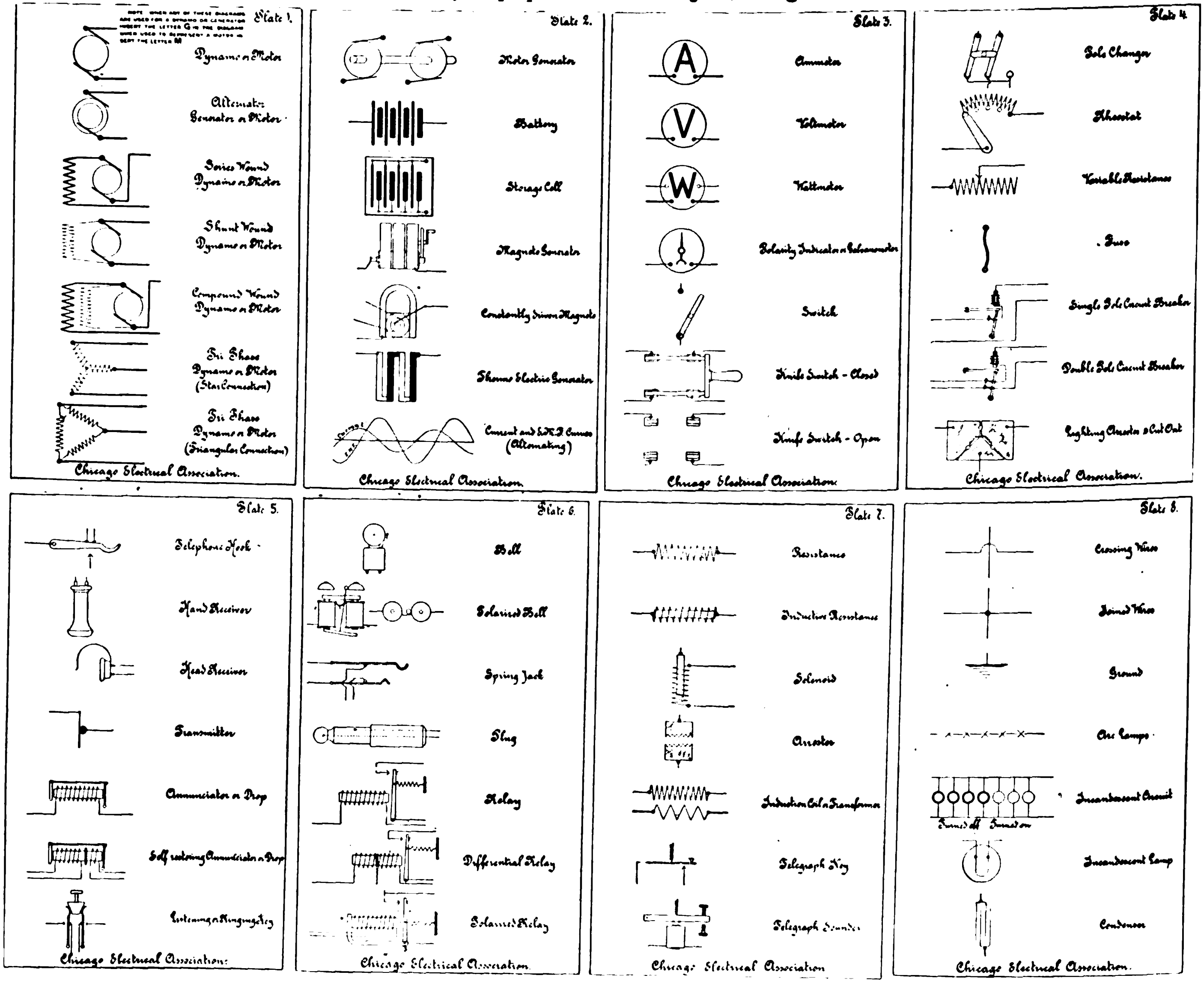
Am.Elec.

branch in parallel with another containing an inductance in series with a 50-volt lamp; in addition there is a 50-volt lamp in the conductor, *A B*. The resistance of the inductance will not be considered, as in any practical case it would but very slightly affect the result. We will anticipate somewhat by stating that this arrangement represents a paradox somewhat similar to that in the previous article, and is therefore of particular interest.


.4 amp.
5 mf.
1 amp.
97
50
84
97
20
95.7
.76
.4
1
43°
Am.Elec.

FIGS. 9, 10 AND 11.—INDUCTANCE AND RESISTANCE IN PARALLEL WITH CAPACITY AND RESISTANCE.

We will assume that .4 of an ampere passes through the lamp in series with the condenser, and 1 amp. through the lamp in series with the inductance; that is, the latter lamp will be at full candle power while the filaments of the former will barely glow. It is desired to know what current will flow through the lamp in the circuit, *A B*, and also the value of the inductance in millihenrys in order to bring about the desired result.


Slate 1.
Dynamo or Motor
Alternator Generator or Motor
Series Wound Dynamo or Motor
Shunt Wound Dynamo or Motor
Compound Wound Dynamo or Motor
Tri Phase Dynamo or Motor (Star Connection)
Tri Phase Dynamo or Motor (Triangular Connection)
Chicago Electrical Association.
Slate 2.
Motor Generator
Battery
Storage Cell
Magneto Generator
Constantly Driven Magneto
Thomas Electric Generator
Current and E.M.F. Curves (Alternating)
Chicago Electrical Association.
Slate 3.
A
V
W
Ammeter
Voltmeter
Wattmeter
Polarity Indicator or Galvanometer
Switch
Knife Switch - Closed
Knife Switch - Open
Chicago Electrical Association.
Slate 4.
Pole Changer
Rheostat
Variable Resistance
Fuse
Single Pole Circuit Breaker
Double Pole Circuit Breaker
Lighting Arrester & Cut Out
Chicago Electrical Association.
Slate 5.
Telephone Hook
Hand Receiver
Head Receiver
Transmitter
Annunciator or Drop
Self restoring Annunciator or Drop
Listening or Ringing Key
Chicago Electrical Association.
Slate 6.
Bell
Polarized Bell
Spring Jack
Plug
Relay
Differential Relay
Polarized Relay
Chicago Electrical Association.
Slate 7.
Resistance
Induction Resistance
Solenoid
Arrester
Induction Coil or Transformer
Telegraph Key
Telegraph Sounder
Chicago Electrical Association
Slate 8.
Crossing Wires
Joined Wires
Ground
Arc Lamps
Incandescent Circuit
Turned off
Turned on
Incandescent Lamp
Condenser
Chicago Electrical Association.

CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.

From formula (1) it will be found that when 4 amps. flow through a condenser of 5 microfarads, a capacity E. M. F. of 95.7 volts will be set up; and it is evident that .4 amp. will produce a drop of 20 volts in a 50-volt lamp, the resistance of a 50-watt, 50-volt lamp being 50 ohms.

Referring now to our capacity triangle, Fig. 10, the base will represent the capacity E. M. F. or 95.7 volts, and the perpendicular the ohmic drop or 20 volts; consequently by solving the triangle we will find that the impressed E. M. F. is 97 volts. This must, however, also be the impressed E. M. F. of the inductive circuit, so that in our inductive triangle, Fig. 9, the hypothenuse will be 97; and since a current of 1 amp. is flowing through 50 ohms resistance, the perpendicular will be 50. Solving the triangle, we find that the value of the inductive E. M. F. is 84 volts. By means of formula (2) it will be found that this corresponds to an inductance of 111 millihenrys.

In the case of the inductive triangle, the tangent of the angle between the impressed E. M. F. and current is $84 \div 50 = 1.68$, which corresponds to an angle of 59 deg; and in the capacity triangle the tangent is $95.7 \div 20 = 4.78$, which corresponds to an angle of 78 deg. That is to say, the inductive current lags 59 deg. behind the impressed E. M. F. and the capacity current leads the impressed E. M. F. by 78 deg., or the difference of phase between the two currents is $59 + 78 = 137$ deg.

In Fig. 11 we represent the two currents by two lines drawn to scale and separated by an angle of $(180 - 137) = 43$ degs. Solving this current triangle by means of the footnote formula, or by laying it down geometrically and measuring the length of the third side, we find that the current that will flow through, *B A*, is .76 amp.

In other words, while 1 amp. flows through the lamp in series with the inductance, and .4 amp. through the lamp in series with the condenser, only .76 amp. will flow through the lamp in A B connecting the series parallel arrangement **with the main circuit.**

As the condenser is approximately of the same size as that used in the preceding article, this paradox could be shown in connection with the one there described. Such an arrangement would be a valuable equip-

ment for an alternating current central station, not only for the amusement of visitors but for instruction.

As shown in Figs. 9 and 10, the impressed E. M. F. is 97 volts, but this would not be in phase with the current flowing through, *A B*. This difference of phase may be very simply calculated from the current triangle, but we will not go here through the operation. Its value is 38 deg., from which we find that the component of the E. M. F., which is in phase with that in, *A B*, is .72 amp. Since .76 amp. flows through the lamp in *A B*, the drop in that circuit will be $50 \times .76 = 38$ volts, and consequently the E. M. F. of the mains should be 110 volts. If the circuit available is one of 100 volts, the several currents calculated will be reduced in the proportion of 100 to 110.

CONVENTIONAL DIAGRAMS OF ELECTRICAL APPARATUS.

The illustrations on the preceding page show a system of conventional diagrams of electrical apparatus which has been under preparation for some time by a committee of the Chicago Electrical Association. At a recent meeting of that body the report of the committee, consisting of Mr. Thos. G. Grier, chairman, and Messrs. Kempster B. Miller, S. G. McMeen and C. Wilder, was adopted, and the result of its work is presented to the electrical public for approval and adoption.

As will be noted, the committee has endeavored, as far as possible, to present diagrams which are in themselves explanatory of the object represented. There is no doubt but that this method is preferable to the one in which the symbols only have a significance to the initiated. To some it may seem that the principle has been carried to an extreme in the case of some of the symbols, but even these will probably admit that it is better to err on the safe side than to endanger the adoption of the system by introducing into it what may be considered purely arbitrary representations.

Letters on Practical Subjects

BEHAVIOR OF DRY CELLS.

To the Editor of American Electrician :

If Mr. N. F. Jarvis will make sure that his cells are properly connected in series (that is + to — throughout, and none connected backwards), and measure the voltages with a reliable voltmeter, he will find that the voltage of the whole series is equal to the sum of all the voltages of the cells measured singly. This is true whether the measurements are made on open or closed circuit, providing all the measurements are made under precisely similar conditions. It would appear from Mr. Jarvis' letter that he measured the open circuit voltage of the separate cells when fresh, and then the total voltage of a series of 12 cells after they had been used. Even if this total voltage was measured on open circuit, which is not certain from the letter, the polarization of the cells might account for the discrepancy if the cells had been working for some time at or near their maximum capacity, which seems to have been the case.

Townsend Wolcott.
New York, N. Y.

To the Editor of American Electrician:

In your February issue Mr. M. F. Jarvis gave an account of a supposed discrepancy in the behavior of some dry cells, and asks for an explanation. From the figures given it would appear, however, that the action of the cells was quite normal.

It is evident that 12 cells in series will not send twice the current through a given external resistance that six cells would, as the internal resistance of six cells is added to the resistance of the circuit at the same time that the voltage is doubled. That eight cells in series only showed 5½ volts while each cell gave about one volt may be explained by assuming that the voltmeter used in making the measurements was a low reading instrument of low grade, having only a small internal resistance—about 32 ohms, according to the figures given, which is rather small even for a voltmeter of not more than 10 volts range.

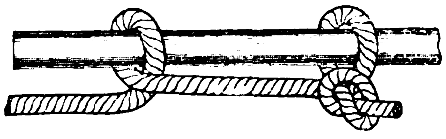
In order to get the right current—twice that given by six cells—Mr. Jarvis requires 24 cells connected in two parallel groups of 12 in series.

Chicago, Ill. P. M. Heldt.

A COME-ALONG KINK.

To the Editor of American Electrician:

Some time when your come-along clamps have failed to come along with the rest of your line-erecting materials, and it would take an hour to go back to the station for them, or when you have the clamps and have been stripping off insulation until you are tired of it, try the scheme shown in this illustration, taken from the German "Elektrotechnischer Anzeiger." It will hold on like a customer to a flat rate when you try to put him on a meter, and it seems to work equally well whether the wire is bare or insulated. After practising it a few times with a piece of wire and a rope, it will come naturally, and is one of the many kinks (in a rope) that it is well to know about.



SUBSTITUTE FOR A COME-ALONG.

Milwaukee, Wis. H. L. Schweigger.

More Electrical Sport.

To the Editor of American Electrician :

Electrical sports seem to be very popular among your readers, and justly so, for "all work and no play makes Jack a dull boy." Another little fragment of "sport" comes to mind with dynamite as an accessory. Close to our electric light station is a maple tree, on which during the past summer an enormous nest of wasps of the genuine "yellow jacket" variety had developed. It was a monster nest, over a foot in diameter. One of the linemen found it. He said the nest contained at least 1,000,000 inhabitants—all fighters. At any rate, we had to put the hose on the lineman before he could get down the tree again past the nest.

On the Fourth of July morning this same lineman came in with an electric cartridge exploder and about two inches of a dynamite cartridge. He pushed a lead pencil into the cartridge, inserted the cap, and taped the whole business so the cap couldn't fall out. A couple of light wires were attached to the leads of the cap, and then the bit of cartridge was placed on a pole and poked up beside the hornets' nest.

The manner in which the hornets punched sting holes in the cartridge was a caution, until a couple of the boys touched the wires to the bus bars. There was a bang, and a puff of smoke, but not a single wasp remained. Not a fragment of the big nest remained, and never a bit of the paper which composed it was to be found. The whole business seemed to have been utterly pulverized and dissipated in the atmosphere. Even the bark was blown from the limb of the tree.

Andrew J. Rodgers.
East Pepperell, Mass.

Another Electric-Bell Arrangement.

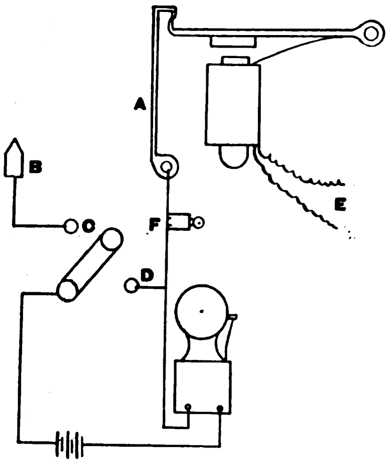
To the Editor of American Electrician :

The account of Mr. Roy J. Tompkins in the January issue reminds me of another annunciator arrangement on somewhat similar lines. In a certain shop there was a private telephone, and at night it was often desirable to call up the watchman, who, having a watchman's clock to attend to, could not always be where he could hear the telephone bell, and delays were frequently met with in getting connection with him.

To cure this trouble the annunciator, *A*, was put in, the wires, *E*, being the main line wires to the instrument. This told the watchman that a call had been made for him, but he was obliged periodically to inspect the office to see if a call had been made. In the centre of the shop was a ten-inch gong, rigged with a vibrating stroke arrangement by means of a small vibrating bell at, *F*. The hammer of this bell was weighted so as to work slow enough to allow the large gong to respond, and when the annunciator drop fell as a call was received, contact with the local system was made at, *B*, by the annunciator drop falling upon *B*, in metallic contact therewith.

At night, upon leaving his office, the foreman would place the switch upon, *C*, so that the local circuit could be closed by the falling of, *A*, upon, *B*, thereby letting the ten-inch gong set up a racket which could be heard all over the works, and which would continue until the watchman appeared and reset the annunciator.

In the daytime the large gong was used for another purpose. Each of the shop foremen was given a number, 1, 2, 3, etc., and when the number was struck on the large gong, it was understood to be a signal for that particular foreman to hustle, post-haste, to the office. By swinging the switch lever to contact, *D*, thereby completing the local circuit through the battery and gong, but not through the jingle bell, the switch was used to give the required number of strokes to make the signal.



ELECTRIC BELL ARRANGEMENT.

George Eastlake.

New Brighton, S. I.

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Magnetizing Galvanometer Needles.

To the Editor of American Electrician:

Under the above heading in the February number of this journal is a criticism of the method for magnetizing galvanometer needles, given in an article by me in the January number. To be sure, such a method would be unnecessarily refined for making galvanometer needles when sewing needles, watch spring and steel tape ⅛ in. wide are used, and comparatively few of them at that; but when a large number of needles must be made up into an astatic pair, where sensitiveness is required, experience has proved the method which I described to be exceedingly successful and satisfactory.

None of our galvanometers contain less than ten wire needles, and one had as many as sixty-eight fine ones; the suspension holding the latter number being also remarkably light in weight, considering the large number of needles on it. Now, to have first magnetized all these needles, even in pairs, and then to have assembled them properly, would have been exceedingly tedious, for besides being so small, they would be continually sticking to each other and getting out of place. Even if this was successfully accomplished, the set would not necessarily be anywhere near astatic, because even if they were originally magnetized equally and half of each needle used on each set, assuming that none were mixed, which is unlikely where there are ten or more, the working and handling of them would be very apt to alter their magnetic strength unequally, and consequently give a system far from astatic, and therefore not as sensitive as it ought to be.

By first assembling the needles and magnetizing them in an apparatus, as described by me, just before the final setting up of the galvanometer, the set will be as nearly astatic as it is possible to make it, for the same magnetizing force acts alike on each set. This magnetizing apparatus only requires from two to four bichromate cells to give a sufficiently intense field. Furthermore, it can be easily made by the use of a few ordinary tools, such as a hammer, saw, brace, bit, hacksaw and file. The one illustrated in my original article was made adjustable, so that it could be used to magnetize systems of various dimensions, but where only one set or size is to be magnetized, it could be simplified. It seems to me that this would be evident to any one.

A 393 ohm galvanometer, which has been in constant use and whose needles have never been re-magnetized since they were made, about three years ago, was recently tested. Its figure of merit was 91x 10^{-10} amperes; that is .0000000091 amperes gave a deflection of one millimeter when the mirror and scale were one meter apart. I have good reason for believing that by re-magnetizing this set the figure of merit could be reduced to 40x10^{-10} amperes. This set of needles was tempered by an inexperienced person, which may account for a slight loss in sensitiveness which I am reasonably sure has taken place. Considering that such good results were obtained with the first and only set of needles made by this person is to me certainly a recommendation of the method used.

While it may be possible to get ordinarily good astatic sets when a few needles only are used, by the method described in the February number, I should be very much surprised if they can be made as nearly astatic, and therefore as sensitive, as by the method described in my article; and where the number of needles are large, the use of the latter method is still more advantageous.

H. S. Webb.

South Bethlehem, Pa.

◆

Some Testing-Set Adjusting Kinks.

To the Editor of American Electrician:

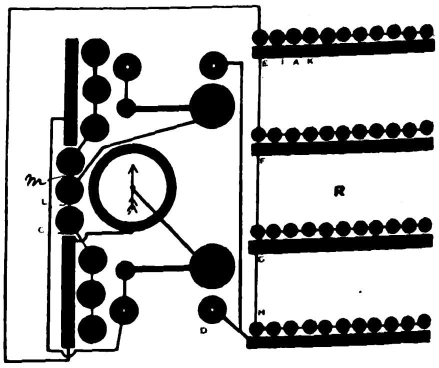
In constructing the testing set, or, more properly speaking, the Wheatstone bridge, which was described in recent issues of this journal, there came up points too numerous to mention in the constructive description, without lengthening the subject matter a point beyond the limit.

The manner of placing pins or nails has already been mentioned, but nothing was said about placing on the pins a sufficient quantity of wire to form one of the coils—two turns, one up and down, for the 100-ohm coils, and then putting on ten turns down, and ten up, for the 1000-ohm coils. But that was the method I employed, and after putting the wire on the pins double, the ends were connected to a battery with a 1000-ohm resistance galvanometer in series, as a test for continuity of the wire.

Then the central fold of the wire was cut, and the galvanometer watched for any evidence of short-circuiting. The instruments were kept connected until the coil was entirely wound, thereby detecting, at the instant it occurred, any contact of the wires through the insulation.

As described in the article, some of the coils were wound double many fold, by catching all the ends of the doubled wires and winding the ten on together. This was found to be considerable trouble; therefore the wooden reels, or spools carrying the graduated coils, were fitted with a bit of sheet brass at each end, and a bit of wire soldered to each bit of the brass. One piece of wire served as a crank for revolving the spool; the other wire was left straight as a bearing for the other end of the spool. Three bits of wood, nailed up together, with a couple of holes slotted in for the wires, served as a mount for the spool and its crank.

My assistant lifted one loop after another from the pins, while I wound the wire on the spool and watched the galvanometer. After the coils had been wound, and tested down to within a fraction of an ohm, they were soaked in melted paraffin, before being soldered on and finally adjusted. This prevents, once for all, any possible change in the conductivity of the insulation of the wire, through two or more of the coils being pressed together—something which is very apt to happen if the precaution noted is not taken in time.



ADJUSTING RESISTANCE COILS.

After making all the wire connections of the box according to Fig. 63 (December number) the unit coils were soldered on and tested up to the one-ohm coil, which is sent out with the plans. Before this is done, the plugs O, P, Fig. 67, should be placed in contact, and the balance bridge carefully adjusted so that the resistance of the flexible connections are included in the balance of the bridge.

With one of the plugs at D, L, and the other, which may be caught in the binding post shown in the engraving herewith, at D, we can, by putting working plugs in C, E, F, G and H, secure a circuit through the instrument with practically no resistance except that of the connections and contacts. Then, by moving plug E to hole I, and placing the one-ohm coil in the mercury cups on bridge, the first one-ohm coil can be adjusted so as to include all the resistance of the connections and the necessary plug contacts in the bridge.

By replacing the plug at E, and putting the slit plug so as to bear against 3, at M, the one-ohm divisor coil at L may be adjusted. In the same manner, by making a 10-ohm coil and balancing it in the bridge mercury cups against the sum of the 10-unit coils, the 10-ohm coil of the divisor may be adjusted, then the hundreds and thousands may be worked up in the same manner.

But after the first coil of the units has been adjusted, different connections are necessary. The box and plug resistance has all been deducted from the first coil of each set; therefore the rest must be full measure—1, 10, 100 and 1,000 ohms. To adjust the other coils, remove the split plugs from M or L, and from D, and place one at I, the other at A, and balance as before, by adjusting the length of wire in the coil. So proceed with all the other unit coils, then with the tens, hundreds and thousands, adjusting the first of each with all the contact resistance in circuit, the other nine coils to full resistance.

The multiplying coils may be adjusted as we go along, by simply changing the contact plug from D to 2, and testing with the other plug at L, instead of at M, when the ratio coils are being adjusted or measured. Remember this point: Plug goes in L, when adjusting graduated coils (those at R) and the multiplying coils, and it goes at M when adjusting the divisor coils.

If another bridge is at hand it may be used for adjusting all the coils, the balance bridge being dispensed with, and each of the coils measured up to the other bridge. But first, the resistance of the flexible connections must be measured when both the split plugs are in adjacent contact with a bar, say at E, I. In the rigging I used, the resistance was .017 ohm. A split plug was then made to go in the completed box, and the two parts connected with enough resistance wire to give exactly .017 ohm resistance. In other words, with the split plugs at I, A, a balance on the master box was obtained by placing the new split plug in one of the O holes of the R coils, and then adjusting the wire until a balance was obtained.

With this arrangement, to adjust the coils it is only necessary to plug them in one after the other, and also plug in an equal resistance in the master box, adjust the coil, then plug in another coil, etc. In this fashion all the coils may be adjusted without moving the split plugs, except to work the multiplying coil.

It is a delicate work to adjust the coils exactly, or as near as the sensibility of the galvanometer will permit, and it is a still more delicate operation to solder the twisted ends of the adjusted coils, and not have the solder change the resistance during the operation. I gave up trying it, and cut up some bits of sheet lead one-eighth inch square and thick. After close adjustment, one of these bits of lead, with a small awl hole through it, would be slipped on the twisted wires and then squeezed solid with heavy pliers. After this the lead was covered with very hot sealing wax. I don't know how long this adjustment will stand, but it has not yet shown any signs of failure, with the box in daily use, under 12 to 24 volts of battery.

Brooklyn, N. Y. JAMES F. HOBART.

ELECTRICAL CATECHISM

191. Explain how a rotary transformer changes current from alternating to continuous.

Let Fig. 1 represent a simple ring armature revolving between a pair of magnetic poles; suppose the ring is wound with wire as shown, two opposite points being connected with collecting rings, *C* and *C*, upon which brushes make contact to take off the current; for the present neglect the commutator and the two brushes shown in heavy lines. When the armature is in the position shown, all the wires on each half are sending current in the same direction, say, up, making the outer ring positive and the inner ring negative. Now suppose the armature has revolved a quarter turn so that the connecting wires are horizontal instead of vertical, as in the figure; then, as before, all the wires on each side are trying to send current up toward the top, but there is no connection at the top to take it off; the E. M. Fs. on the two sides of each half are opposed and exactly equal, so that there is no net E. M. F. between the collecting rings, and there is no current at that instant. Between these two positions, the current and E. M. F. vary more or less uniformly, each following closely the sine curve described in earlier numbers. Next suppose that the armature is provided with a commutator, each section of the winding being connected with a commutator bar, as suggested by the circle of heavy lines; the brushes, *B* and *B*, will make contact with different bars and therefore with different sections of the armature winding, unlike *C* and *C*, which always connect with the same armature section. It is seen that the armature wires between *B* and *B* all tend to send current in the same direction at all positions of the armature, so that a continuous current may be taken from *B* and *B*, while at the same time an alternating current may be taken from the same armature by *C* and *C*. Since either a continuous or an alternating current may be obtained from the same armature, it makes no difference what causes the armature to rotate, whether mechanical power applied at the pulley or electrical power applied at either pair of brushes. As will be explained later, the same armature is equally adapted for use as a dynamo or as a motor. Therefore, if continuous current be applied to the brushes, *B* and *B*, alternating-current may be taken from the brushes, *C* and *C*.

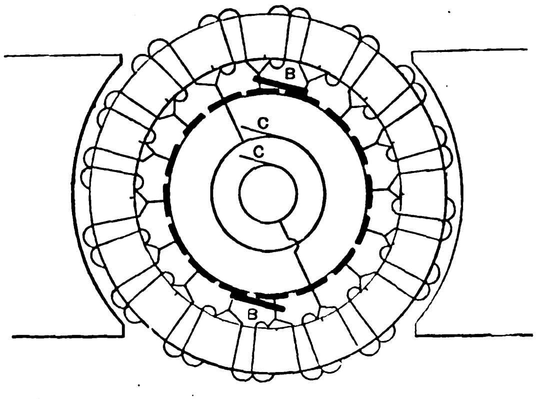


FIG. 1.—DIAGRAM OF ROTARY TRANSFORMER.

192. In a rotary transformer, is the voltage between the alternating-current brushes the same as between the continuous-current brushes?

No. The alternating voltage is only about seven-tenths of the continuous voltage. By reference to Fig. 1 it is seen that the alternating voltage is at a maximum when the armature coils connected with the collecting rings are also connected with the continuous-current brushes. The maximum value of the alternating voltage is therefore equal to the steady value of the continuous voltage. But the effective or mean value of the alternating voltage, supposing it to follow the sine curve, is only 71 per cent. of the maximum. For example, if the continuous voltage is 500, the alternating voltage is 500 × 0.71 = 355. In practice the alternating voltage is somewhat less than the simple theory calls for, being influenced by the setting of the brushes, the distribution of the magnetic field and some complex elements.

193. What kind of alternating currents are given by a rotary transformer such as described in 191?

Such a rotary with only two collecting rings would give a single-phase or monophase current.

194. How could a two-phase current be obtained?

Two phase currents could be obtained by having a second pair of collecting rings connected to the armature winding at points midway between the first ones. The E. M. F. between the second pair would be at a maximum when that between the first pair was at zero. The two currents would thus be at right angles, or in other words, in quadrature, or 90 degs. apart. The effective values of the two currents would be equal.

195. How could three-phase currents be obtained from a rotary?

By connecting three collecting rings to three equidistant points, as suggested in Fig. 2.

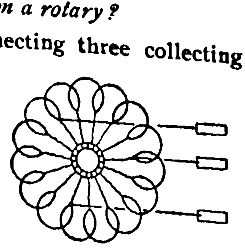


FIG. 2.—DIAGRAM OF THREE-PHASE ROTARY TRANSFORMER.

196. What is the relation between continuous and alternating voltages in a three-phase rotary transformer?

According to the elementary theory, the effective voltage between any two of the three lines is 62 per cent. of the continuous voltage. Actually it is somewhat less, for reasons similar to those mentioned in 192.

QUERIES AND ANSWERS

What is the discharging rate of storage batteries per square foot of positive surface? C. H.

From 8 to 9 amperes. More ampere-hours will be obtained if this rate is decreased, and less if it is increased.

How are very high resistances made? J. A.

One kind consists of a lead-pencil mark on a piece of ground glass between tin-foil terminals. Another consists of one or more U-tubes of glass of small internal diameter, filled with water.

What will be the pole strain of a 60-foot span of 5-16-in., 7-strand steel wire supporting two No. 0 trolley wires, 10 ft. apart, the sag being 14 ins. E. J. B.

The strain will be 1,000 pounds, the distance between spans being assumed 125 feet.

1. Can I use a 1-16 h.p. 500-volt motor as a dynamo? 2. What would be the winding of such a motor to run as a 55-volt machine? F. F.

1. Probably yes, though this cannot always be predicted in the case of small motors; belt to power and see the result. 2. See articles by Mr. Cecil P. Poole in this and February issue.

Would a neutral wire, grounded at both ends and run between two grounded telephone circuits, prevent induction between the circuits? D. W. M.

No. For instance, if the current in one circuit were falling at the same rate as the current was rising in the other, the neutral wire would be "dead" and the two circuits would react on each other as if the neutral were not present.

Does any current flow in the induction windings of a three-phase synchronous motor after the armature has gotten into step? J. N. R.

Yes. The torque of the motor depends upon three factors—strength of field, amount of current in the induction windings, and the angle of phase between the induced current and the field current. If no current flowed there could be no power.

I have a dynamotor, the primary cummutator of which has every other bar blackened. What is the cause? G. W. B.

This occurs when, of two sections in an armature slot, one has a greater number of turns than the other. One section of the winding has in this case a greater self-inductance than the other, and every other bar may become blackened at the retreating edge from the consequent sparking.

Why are shunt-wound instead of compound-wound generators used in large direct-current central stations? E. G.

In order to give greater control over regulation. The ideal advantages of compounding only apply in the case of a generator running singly and always on the same circuit. When a machine may be switched from one circuit to another, and run in parallel with two or more machines, shunt regulation is ordinarily necessary.

How can I find the size of a wire for a three-phase system? B. H.

Leaving aside inductance, calculate the size of wire for the ordinary direct-current two-wire system for the same voltage and kilowatts; then each of the three wires of the three-phased system will be one-half the size thus found. If inductance and power factor are considered, use Mershon's table and chart, published by the American Electrician Company.

1. When a condenser and an inductance are connecting in series across an alternating circuit of 100 volts, and the pressure at the condenser terminals, as measured by a volt-meter, is 250 volts, is the strain on the insulation of the condenser as great as if the condenser above were connected across a 250-volt alternating current circuit? 2. What insulation should be placed between the alternate sheets of tinfoil when the voltage is not to exceed 250 and 500, respectively. L. C. W.

1. Precisely the same. 2. No practical data on condenser insulation have been published.

Keeley says that his new force, which he calls "opergy," is obtained by "blending positive and negative electricity with electricity of the third stage or element," thereby enabling the force of gravitation to be partly reversed. What is the third state of electricity? W. M. C.

Adopting the Socratic method and using the nomenclature of Keeley we may reply as follows: The blending of anhydrous aqueous vapor with non-thermic isotropic caloric in the presence of static etheric vibrations produces the elixir of life. What is non-thermic isotropic caloric?

How can I connect an annunciator to a 110-volt circuit? J. W.

Disconnect the leads from the battery, connect one direct to one side of the 110-volt circuit, and the other to a 110-volt lamp, the other side of the lamp being connected to the second circuit wire. To provide for lamp breakage, use four lamps connected in parallel series; that is, each pair in series, and the two pairs in parallel. If one lamp breaks, half the current will pass through the other pair.

When is it necessary to know which is the positive or negative terminals of a dynamo or of a line, and how is this determined for an incandescent lighting machine? H. E. K.

Usually only when a storage battery is to be changed from the circuit. When ammeters or voltmeters are marked + and —, they can ordinarily be connected up by trial. To determine polarity, place two pieces of lead in a glass containing a solution of sulphuric acid (10 of water to 1 of acid), and connect to the circuit with a lamp in series; the plate connected to the + side will turn brown.

I have rewound the field of a railway motor, but in one section where there have been two before, using the same wire and same number of turns. On trial the motor sparked badly, jumped and threw out the circuit brakes. Could this be due to winding in one section instead of two? S. B.

No. Part of the field is probably cut out by a double ground or short circuiting of part of the windings, as this would cause an abnormal current to flow and increase the speed. Find the drop in each coil by sending through a normal current and measuring the voltage between the terminals, which should be indentical.

Does a booster generate current in raising a voltage? L. H. P.

Where there are several circuits from the same bus-bars, and the drop on one of the circuits—usually feeding a distant point—would otherwise be too great, a booster is put in that circuit, which adds an E. M. F. equivalent to the excess of drop. The current flowing in the booster circuit will be the total E. M. F. in it divided by the total resistance of the circuit; part of the current will thus be due to the booster E. M. F., if one chooses to look at it in that way.

I have a 30 k.w. alternator with exciter on the same shaft. How can I charge a couple of storage cells from the latter? P. G. C.

Put the cells in series with the alternator field windings; the small back voltage thus introduced may be compensated for by a segment or two of the exciter rheostat. To determine the polarity of the circuit, connect the exciter binding posts with two pieces of lead in a glass of water acidulated with sulphuric acid, having a 50-volt lamp in the circuit. One of the pieces of lead will turn brown, and the brown plate side of the battery should connect to that side of the exciter.

What is the length of the longest and shortest wave of electricity, and the length of a wave of light? W. M. C.

The length of a given electric wave is found by dividing the velocity of light per second by the electrical frequency per second. Consequently, with a frequency of 25 the corresponding electric wave has a length exceeding 7,000 miles. Lodge, it is said, has produced and measured electric waves only eight inches in length. The length of light waves varies from 3 to 1.6 hundred-thousandths of an inch, the latter corresponding to the violet portion of the spectrum, and the former to the red portion.

What should be the windings of a magnet for a coil clutch for a current of 8 volts and 1 ampere? G. W. L.

A "current of 8 volts and 1 ampere" is a very ambiguous expression. If you put 1,000 ohms in circuit would you still have 8 volts and 1 ampere? If the source of E. M. F. is an 8-volt battery which gives one ampere when on short circuit, then the winding should be a coil embedded in a circular groove in the face of one of the cones; the gauge of the wire will depend upon the size of this groove and should be so selected that the coil which fills the groove will have a resistance of 8 ohms, using, of course, copper wire.

In making a 5-inch induction coil, using 5½ pounds of No. 36 wire, will cotton-covered wire answer, the layers being separated by writing paper? B. H.

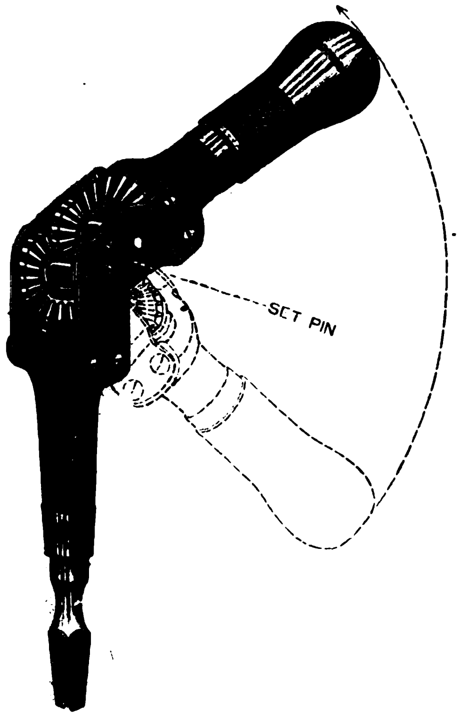
Use cotton-covered wire loosely wound, and separate the layers with one or two thicknesses of filter paper; then bake and saturate with hot paraffine, filling in also with hot paraffine when the coils are in place. Leave at least a half-inch space between primary and secondary. Wind primary with a single layer of No. 12 or 14 wire, the spirals of which may be separated considerably if the supply of current is large. The amount of current will be fixed by the heating of the primary, and to adjust the current if taken from a lighting circuit, use non-inductive resistance in the exterior circuit. You may be disappointed in your assumption that you will get a 5-inch spark from 5½ pounds of secondary wire.

Apparatus and Appliances

NEW ANGULAR BIT STOCK.

The accompanying cut shows a tool especially adapted for the use of electricians, who frequently have many holes to bore in wiring, where there is not room enough to work the ordinary brace and other boring tools. The tool is also useful in electric railway work, power plants, telephone work, etc.

The gearings are of steel and the tool is nickel-plated and japanned. It is 22 ins. long over all and weighs 2 lbs. The gear attached to the chuck is 1½ ins. in diameter, and the other is 1 in. By turning the bit stock with a brace three times around, the chuck revolves only two times, which gives one-third more power on the bit than if the gears were all the same size. By pulling out a set-pin, this can be turned and locked at the various angles, as shown by the dotted lines. At the limit, which is beyond a right angle, the tools works as easily as at other adjustments. By reason of the large gear attached to chuck, it is claimed that an inch can be bored with less power than a ¾ in. hole can be bored with any other angular bit stock in the market. The manufacturers are C. Meister & Co., 726 Union Street, Allentown, Pa.

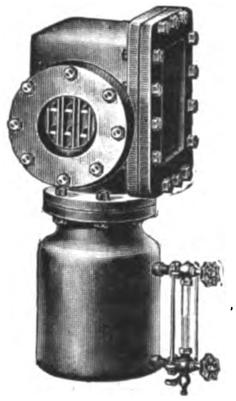


ANGULAR BIT STOCK.

STEAM AND OIL SEPARATOR WITH SIDE FLANGE.

The importance of frequent cleaning of a separator, and especially an oil separator, is as marked as the need of thorough working, as the one is dependent upon the other, and in the matter of making a selection one should consider carefully this convenience. There are very many places in which there is not sufficient headroom for the removal of the baffle plates of a separator, even though it be constructed with such plates. This apparent need has caused the makers of the Bundy separator to produce one with side flange through which the baffle plates may be slipped with perfect ease.

The separator shown herewith is interchangeable; that is, it may be put in so that the side flange may be on either side, but care must be used to see that the baffle plates are put in so that their flat front may face the incoming steam, as this side alone has the capillary openings through which the oil and water may enter and go to the receiver below on gravity action.



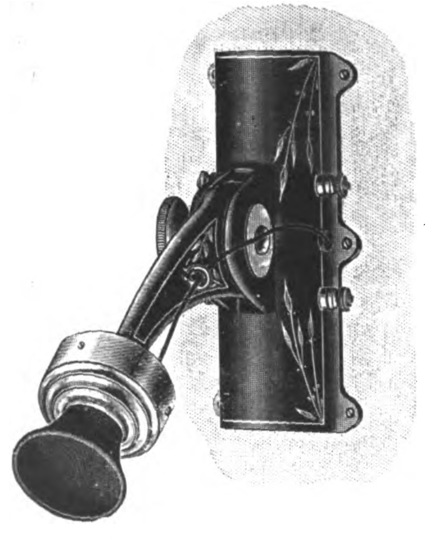
SEPARATOR WITH SIDE FLANGE.

The rear side of the Bundy separator baffle plates has the vertical posts rounded for the easy passing of the steam. They are so constructed that the posts set staggered to each other; in other words, a post in one baffle plate sets directly back of a space in the plates in front of it, thereby causing the steam to pass through in a zigzag course.

The Bundy separator described is made by the A. A. Griffing Iron Company, 66 Centre Street, New York.

TELEPHONE TRANSMITTER ARM.

Arm transmitters are never satisfactory when the contact between lever and base is used for the return of current from transmitter to battery, as any looseness of the parts or foreign substance therein will seriously impair the efficiency of the instrument. In the arm transmitter shown herewith, a new path is provided, which acts independently of the contact between lever and base, and thus prevents the trouble which has done so much toward limiting the popularity of arm transmitters. While the contact between lever and base is no longer for electrical connection, at the same time the mechanical features of this contact have been greatly increased, and the adjustment is very simple. The arm described is made by the Chicago Telephone Supply Company, 118 Quincy Street, Chicago.

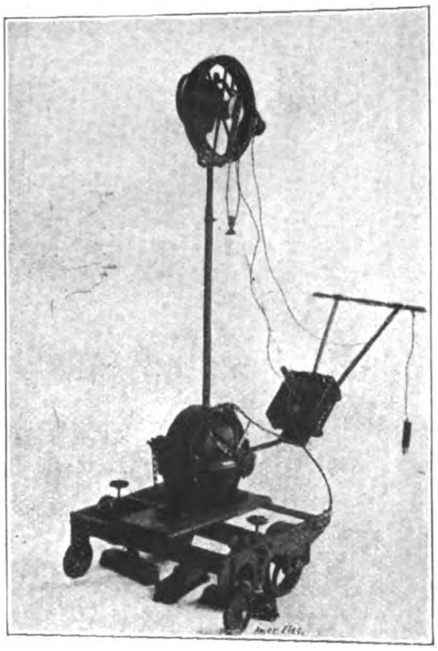


TRANSMITTER ARM.

ELECTRIC FLOOR SCRUBBING MACHINE.

The accompanying illustration represents a machine for floor scrubbing. The main frame carries several scrubbing brushes, which are pressed against the floor by means of a spring, and are geared with an electric motor so as to be revolved at the rate of about 400 revolutions per minute. The wheels are rubber tired, and the machine is easily shoved along the floor by its handle.

The machine weighs about 300 lbs., its frame being about 30 ins. square. The brushes are so set that they will run practically to the base board of a wall. The motor receives its current by means of an attachment to any convenient incandescent lamp circuit. In action, water is thrown on the floor, and the scrubbing machine guided over by the operator. In place of the scrubbing brushes, however, sand-paper blocks, or blocks of stone, may be substituted, and thus the machine may be used to dress down wood or mosaic floors.



FLOOR SCRUBBING MACHINE.

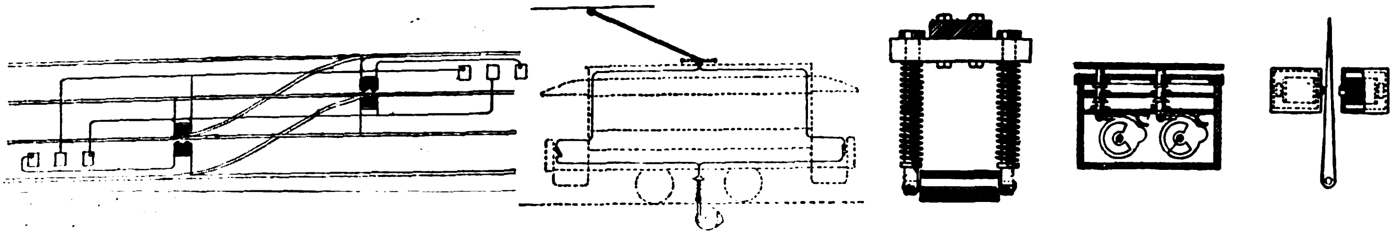
The machine illustrated has been in actual service for two years in the Hickox Building, Cleveland, doing work on eight floors; formerly it required 10½ hours' labor to clean these floors, which has been reduced by the machine to 2½ hours, making a saving of $75 each month in this one building.

The inventor is Mr. H. F. Ackerman, chief engineer of the Hickox Building, Cleveland, O.

SWITCH OPERATING MECHANISM.

The device illustrated is an arrangement for operating switches for electric railways, the object being to provide a mechanism simple and comparatively inexpensive, and which will be completely under the control of the motorman. From the car shown in Fig. 2, is a projection, shown in detail in Fig. 3. Under the track is a box shown in Fig. 4, on the top of which is mounted a plate against which the roller of Fig. 3 strikes when the car passes over it. The plate is thereby depressed, which makes an electrical contact within the box whereby the magnets shown in Figs. 1 and 5, and situated at the switch points, are actuated. When contact is made from the car with the plates, the magnets are energized and the switch tongue shown in Fig. 5 is drawn toward one of the magnets. As the car approaches the switch, the tongue closes the latter, and when the car leaves the switch the opposite magnet attracts the tongue the other way, thereby opening the switch. This mechanism can be applied to a siding, car house entrance, cross-overs, etc., and is of particular utility in side-tracking a disabled car. As will be seen in Fig. 2, the current is taken from the trolley, the switch current being controlled by the motorman.

The inventor of the above described apparatus is C. W. Yerbury, 6 Belleville Avenue, Newark, N. J., who will be pleased to send a more detailed description to any one who may apply.



FIGS. 1, 2, 3, 4 AND 5.—ELECTRIC RAILWAY SWITCH OPERATING MECHANISM.

ENGINE STOP AND SPEED LIMIT.

The accompanying illustrations show two devices which will be recognized as of great value in the prevention of steam engine accidents. Fig. 1 shows an attachment to an engine stop valve which, in case of accident, will close the valve by simply pressing a button, of which any number may be used, distributed throughout a shop or factory. The apparatus is connected with the throttle valve by a chain from a sprocket wheel, shown on the right. The power for operating the stop is supplied by means of a cable winding about the drum on the left and having attached to it a weight. When an electric circuit is completed, the magnet shown releases the mechanism and the falling weight closes the throttle valve.

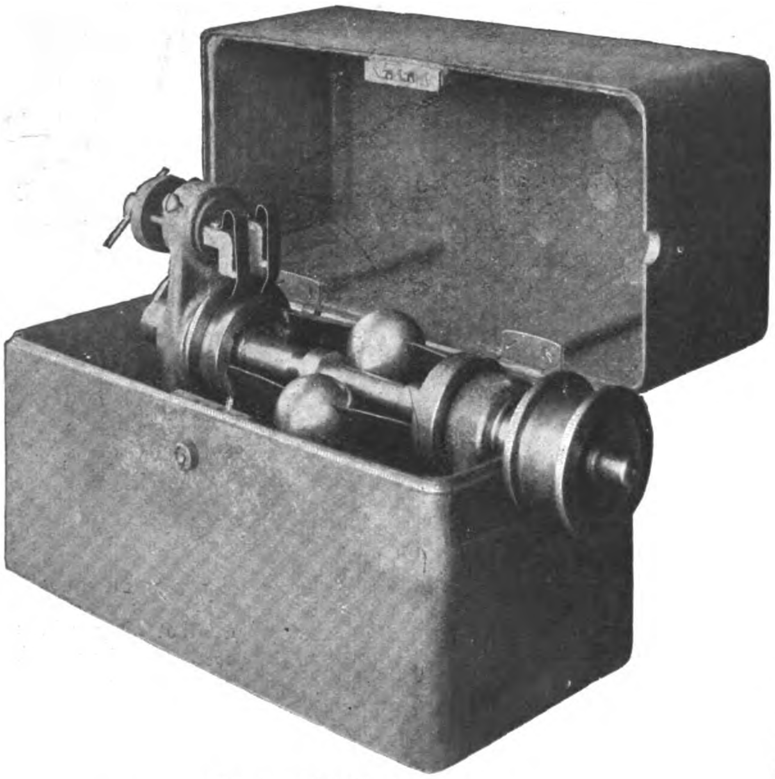


FIG. 1.—ENGINE STOP.

In Fig. 2 is shown a speed limit, the pulley to the right of which is belted to the engine shaft. When the speed exceeds a predetermined amount, the governor balls in flying out complete an electrical circuit through the engine stop, whose mechanism is thus released and the throttle valve is closed. Connected with the engine stop is a bell circuit, and a gong is sounded when the throttle is closed. The above devices, known as the Monarch stop and Monarch speed limit, are made by the Monarch Manufacturing Company, Waterbury, Conn.

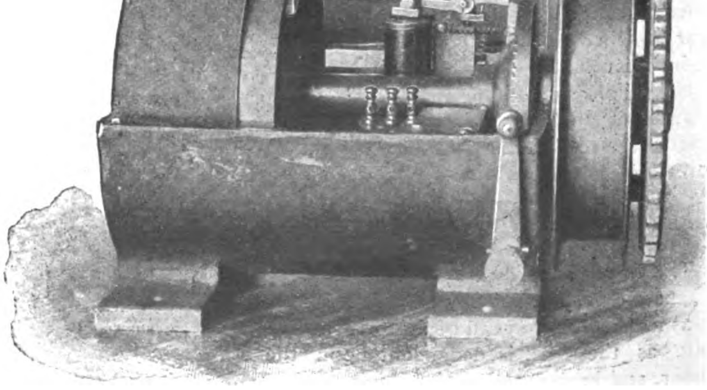
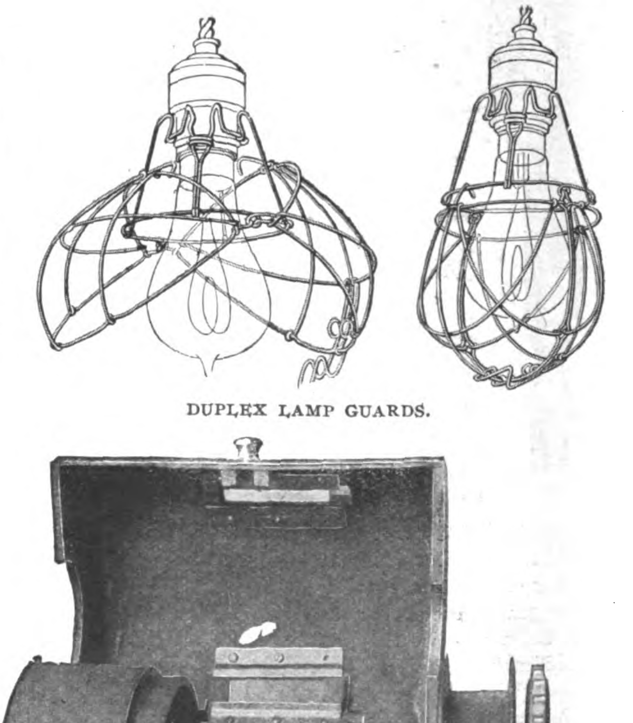


FIG. 2.—SPEED LIMIT.

DUPLEX LAMP GUARD.

The illustrations shown herewith represent the Duplex lamp guard, designed to fit any lamp of 16 or 32 candle power. The lamp can be removed and replaced without taking the guard from the socket, a very material advantage over the average lamp guard; it can also be attached without using a shade holder or other extra



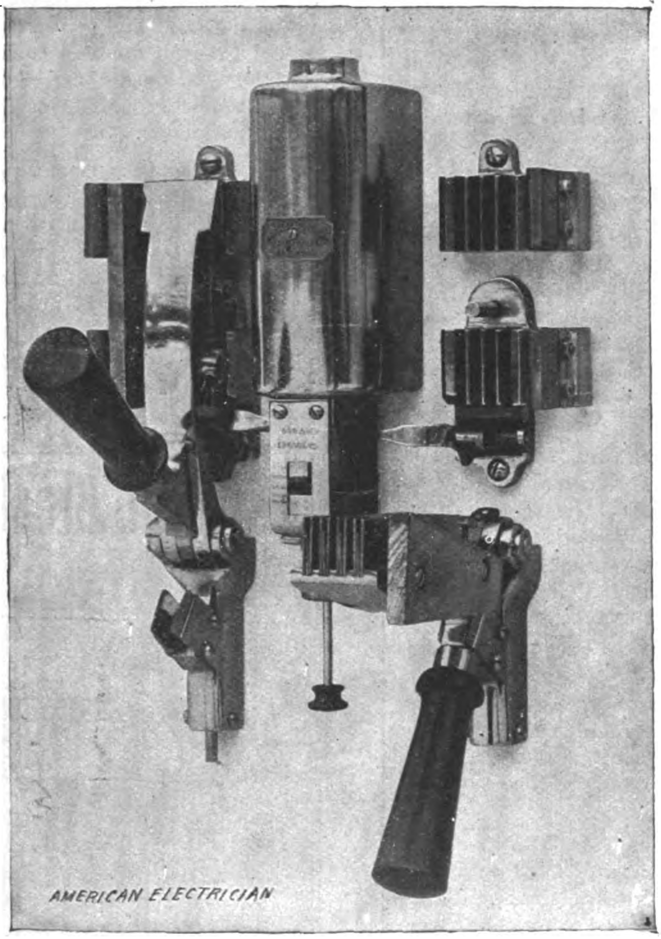
DUPLEX LAMP GUARDS.

contrivance for holding it in place. This particular guard has also a strong steel spring catch to prevent it from joining open. These guards, which are made in several styles and to fit any lamp, are manufactured by the Duplex Manufacturing & Electric Company, 84 Adams Street, Chicago, Ill.

◆

SWITCHBOARD CIRCUIT BREAKERS.

The circuit breaker shown in the accompanying illustration is so constructed that each side of the circuit with the double-pole type is separately closed. Should an overload occur and the operator be holding one side of the switch, the other will automatically fly out and open the circuit, or if both are free, they will open simultaneously upon the occurrence of an overload. All of the arcing occurs on carbon, and the carbon blocks are readily replaced by loosening a couple of screws. The contact blades are detachable by removing one screw, and the blades can be mailed in an ordinary envelope. The construction of these blades is a special one which always insures a perfect contact. The only adjustment necessary consists in raising or lowering the vertical movable core of the solenoid. A scale back of a projection from the core enables the necessary adjustment to be made, this adjustment ranging from 25 per cent under, to 50 per cent over the current which the circuit breakers will continuously carry. This type of circuit breaker, which is particularly applicable for switchboard work on account of all the connections being made on the back, is made by the H. Ward Leonard Electric Company, Bronxville, N. Y.



SWITCHBOARD CIRCUIT BREAKER.

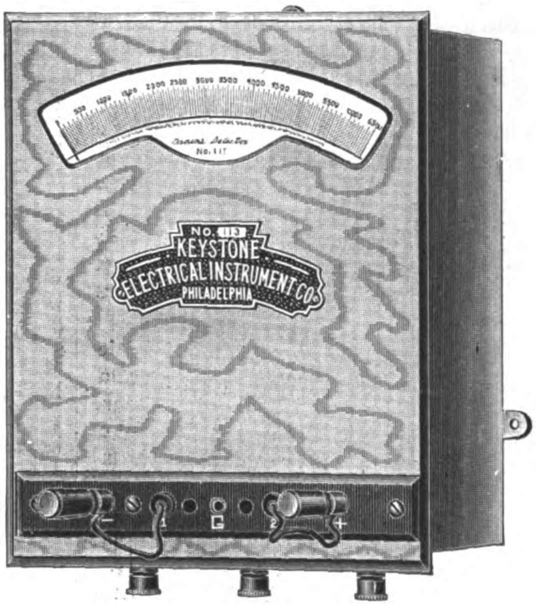
ARC LIGHT VOLTMETER AND GROUND DETECTOR.

The instrument shown in the accompanying illustration is applicable to three uses—as a voltmeter, a ground detector and a galvanometer. As a voltmeter it is used on arc light circuits, and can be so connected as to indicate the voltage of the generator, the voltage of any one of a number of circuits, and also applied as a ground detector to indicate a ground and determine its character and location. It will also replace a cable testing set, which apparatus is apt to be extremely unsatisfactory, owing to the many microphone contacts in the circuit. In connection with a set of switches and a battery of primary cells, or an ordinary incandescent circuit, it can be used to test the continuity of the line and the resistance from the line to the earth during the day, for this purpose being much easier to handle, more accurate in results and quicker in action than the usual sensitive galvanometer and Wheatstone bridge method.

The instrument consists of a compound galvanometer system mounted in a case which effectually shields the parts from the influence of external magnetic action. The scale is practically uniform from zero to maximum reading, the indications are dead beat, and the temperature coefficient of the wire employed is so small that external changes of temperature make no difference in the indications.

At any moment, by means of this instrument the condition of the line may be determined. If there is a dead ground, by means of three readings it may be exactly located, the formula used for this purpose giving the number of the lamp beyond where the ground occurs. If the ground is only partial, its resistance may be similarly determined and also its location. In testing for insulation, only a single reading is necessary, substitution of the value of which in a simple formula enabling the insulation resistance to be exactly determined.

With such an instrument the night attendant may keep a log and in the morning the data thus obtained may be worked out and thus the condition of the line be determined, thereby saving the expense of patrolling the line daily. The instrument described is made by the Keystone Electrical Instrument Company, Ninth Street and Montgomery Avenue, Philadelphia, which has issued an interesting pamphlet in which the principles involved are explained and instructions given for the use of the instrument.



ARC LIGHT VOLTMETER AND GROUND DETECTOR.

◆

TRADE PUBLICATIONS.

DUNCAN METERS.—In a fifty-page catalogue the Fort Wagner Electric Corporations gives a description of the Duncan integrating meter for alternating currents, directions for its installation, care and reading, with other useful information, such as tables of equivalent meter rates, wiring formulas and tables, etc.

STORAGE BATTERIES.—The eleventh edition of catalogue A of the Electric Storage Battery Company, Drexel Building, Philadelphia, contains a number of reproductions of photographic views of storage battery installation in central stations and power houses, which will be of interest to central station and electric railway men. A set of instructions for setting up and operating storage batteries is a valuable feature of the catalogue.

Indicator Piping.—James L. Robertson & Sons, 208 Fulton Street, New York, have issued a circular illustrating indicator piping, of which several styles are shown—with three-way cocks, long-turn elbow cocks, and straight cocks.

Education by Mail.—In a 96-page pamphlet the United Correspondence Schools, 154 Fifth Avenue, New York, give full information concerning their various courses, methods of instruction, etc. In electrical engineering there are three courses, a complete electrical engineering course, an electrical station engineering course and a complete station engineering course. Sample pages of instruction papers are given, which show that the instruction is both practical and thorough.

C & C Bulletins.—It has become the custom of the larger electrical manufacturing companies to issue periodical bulletins descriptive of new apparatus, and of these the bulletins of the C & C Company, 143 Liberty Street, New York, are easily the neatest in form and handsomest in execution. The last three issues (Nos. 120, 121 and 122), are devoted to bipolar, multipolar and ironclad dynamos and motors, respectively. The descriptions are clear and concise, and the illustrations are clear and good.

Outlet Boxes.—Porcelain-lined outlet boxes formed the subject of a catalogue issued by the H. Ward Leonard Electric Company, Bronxville, N. Y., of which type some scores of different forms are illustrated. A table shows that during the year 1897, 81,000 of this type of box were installed in New York City alone. Among the buildings thus equipped we note those of the New York Life Insurance Company, Western Electric Company, Delmonico's, Sherry's and the Astoria Hotel, the latter using no less than 14,000 boxes.

Fire and Burglar Alarm.—The Montauk Multiphase Cable Co., 100 Broadway, New York, has issued several handsome pamphlets descriptive of its multiphase cable and automatic system of fire and burglar alarm, the principal one being profusely illustrated with well executed black and white drawings, showing various applications of the system. The multiphase cable can be used for ordinary bell work, at the same time performing the function of a continuous thermostat which actuates when a temperature of 374 degs. is attained at any point of the cable.

Machine and Hand Tools.—The 1898 edition of the catalogue of the Brown & Sharpe Manufacturing Company, Providence, R. I., has been thoroughly revised, and contains 437 pages, 20 more than in the preceding one. The tables, which form such a valuable feature of this annual catalogue, have also been increased. The principal additions to the catalogue in the way of tools are automatic cutting-off, screw and turret forming machines, bell polishing and universal grinding machines, and new types of face milling cutters, micrometer guages and calipers, spiral gears, screw slottting cutters, and a twist-drill and steel wire guage.

BUSINESS NEWS.

Hugo Reisinger has removed his offices to the fourth floor of the Bowling Green Building, 11 Broadway, New York.

Mr. H. C. Thompson of the Electric Gas Lighting Co., Boston, Mass., was elected manager of the company at its annual meeting.

The Montreal Electric Company.—In a removal notice of this company, which appeared in the February issue, the new address should have been 1898, instead of 1819, Notre Dame Street.

The Buffalo Indicator Company has removed its offices and works to Jamestown, N. Y., and with increased facilities hopes to promptly meet the increasing demand for its indicator and other steam specialties.

Bryan & Humphrey, mechanical and electrical engineers, Turner Building, St. Louis, have issued a neat pamphlet, giving a list of their specialties in engineering work, and a long list of references, which includes some of the best-known names in the West.

The Crouse-Hinds Electric Company, and Pass & Seymour, of Syracuse, N. Y., have leased the store No. 23 Dey street, Havemeyer Building, and moved their place of business to that place. Mr. F. W. Hawkins will be in charge of the New York establishment.

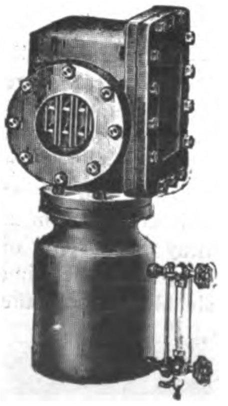
Telephones.—The Allen-Hussey Company, 211 Randolph Street, Chicago, reports gratifying sales in February for its specialties—interior and short-line telephones. These instruments are deservedly popular for their ease in connection, their compactness and reliability.

Sale of Arc Lamps.—The number of arc lamps manufactured and shipped from the factories of the General Electric Company within the past fiscal year has exceeded 24,000. Many thousands of the General Electric enclosed arc are now in service and the introduction of the alternating enclosed lamp has still further increased sales.

Indicators.—It is seldom that a more handsome lot of indicators can be seen than three double sets shipped one day recently by Jas. L. Robertson & Sons, 204 Fulton Street, New York. Some idea of the territory covered by this company is indicated by the destination of the above sets, which went to St. Louis, Kalamazoo and Milwaukee.

Iron-Armored Conduit Outlet Insulator.—The Central Electric Company has taken the Western agency for the Erickson outlet insulator. This outlet insulator is brought out to meet the demands of engineers for a thorough and perfect protection at the ends of iron armored conduit outlets. It very effectually and thoroughly prevents possible grounding of the wires on the iron conduits.

J. A. Lang & Co., manufacturers of steam and electrical specialties, 44 Michigan street, Chicago, have just issued their 1898 catalogue of switches, switch and panel boards, special castings, etc. They call special attention to the metal used in the bases of their switches for all lugs, connections, etc. A very interesting test is shown giving the conductivity of cast copper manufactured by this company.



"Sure Cure for Wet or Oily Steam"

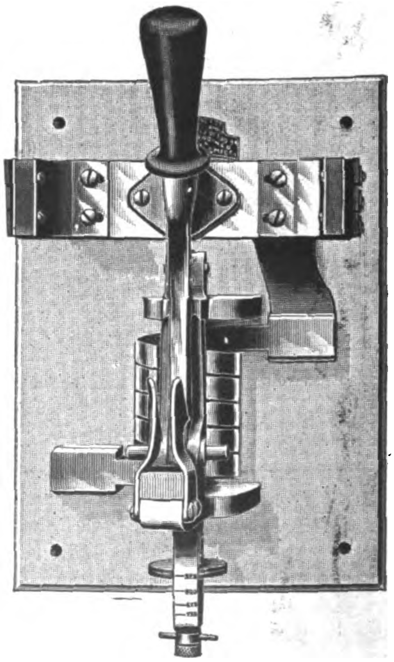
Bundy
Trade Mark

STEAM and OIL SEPARATOR.

OTHER SURE CURES
Steam Traps.
Gravity Pumps.
Feed Water Heaters.
Safety Water Columns.
Exhaust Heads.

A. A. GRIFFING IRON CO.,
66-68 Centre Street, New York.
Boston, Mass. Philadelphia, Pa. Works, Jersey City, N. J.
Send for Book —A E— on "*Sure Cure for Steam, Water and Fuel Wastage.*"

I-T-E Circuit Breakers



The above represents instrument of from 100 to 1250 Amperes. Standard Switch-board Type, Single Pole, Direct Current.

Affording Protection against Grounds and Short Circuits.

A prominent English Engineer is quoted as saying he would not hesitate to short circuit any dynamo, provided it be safeguarded by an I-T-E Circuit Breaker. A large number of these safety devices are in use upon the switch-boards of the leading tramways and lighting stations in Great Britain.

The CUTTER ELECTRICAL & MFG. CO.
1112 Sansom St., Philadelphia, Pa.
120 Liberty Street, New York.

Eyanson & Armpriester have removed to the large building on Commerce street, cor. Seventh street, Philadelphia, their constantly increasing business having made it necessary to seek larger quarters. With more room and increased facilities to handle work promptly they will continue to maintain the standard of the work that has always made the name of "E. & A. Knife Switch" everywhere known.

Carbons for Enclosed Arc Lamps.—Cored carbons and solid carbons for enclosed arc lamps can be made at home beyond all dispute just as good as the foreign article, and there is little doubt but that the Washington Carbon Company is building up a very handsome trade. This enterprising company is to be congratulated upon its work in this line, and every one will wish that it may meet with great success.

The Hercules Float Works, Springfield, Mass., have recently opened an office at 154 Reade Street, New York, which will be in charge of Mr. H. C. Enders, who will be pleased to show samples of the Englehardt Safety Electric Water Columns, which are meeting with so much favor. This company also manufactures seamless copper floats and air chambers, and has also just put on the market a very effective pneumatic tank indicator.

Frank R. Eager, who has recently opened headquarters at Syracuse, N. Y., reports a heavy business from Onondaga dynamos, Janders arc, and Buckeye incandescent lamps. Mr. T. H. Bailey Whipple, the general agent of the Buckeye Electric Company and of the Janders Electric Company, of Cleveland, Ohio, has been doing New York State, and stopped off a week at Syracuse to lend Mr. Eager a helping hand.

Mr. F. M. Hawkins, New York agent of the Crouse-Hinds Electric Company and the Pass & Seymour Company, of Syracuse, N. Y., has removed his office and show rooms to 23 Dey street, on the ground floor of the Havemeyer Building. This should be a very desirable location, as it gives not only a very attractive office, but a large show-window on Dey street for a display of samples in the line of switch and porcelain specialties manufactured by the above companies.

Electrical Equipment of a Sky Scraper.—The complete wiring system, as established and standardized by the Interior Conduit & Insulation Company, will be installed exclusively in the new Park Row Building, the largest office building in the world. Some 250,000 feet of interior conduit will be used in the installation, which will be made by the New York Electric Equipment Company. The Sprague high-speed, vertical electric elevators will also be used in this building.

The Diesel Motor.—During the past year the Diesel motor has created a sensation in both mechanical and scientific circles in Europe, owing to the high efficiency claimed for it and the new thermo-dynamic principles applied in the machine. Recently a company which has purchased the American patents of the motor has been incorporated under the laws of the State of New York as the Diesel Motor Company of America, and has established headquarters at 11 Broadway.

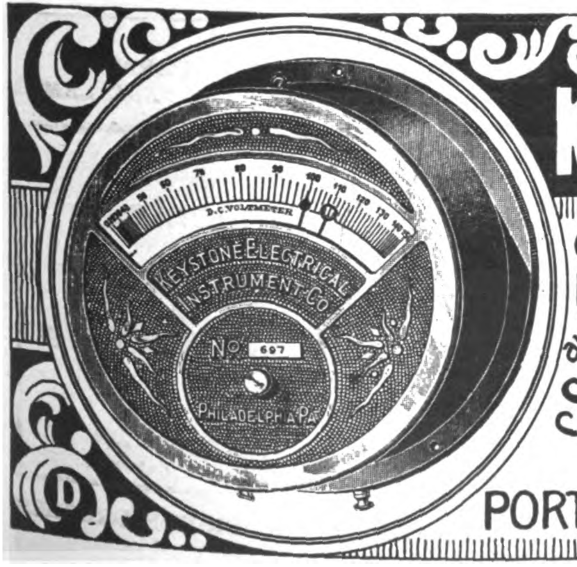
W. R. Garton, 414 Ashland Block, Chicago, has just been elected general manager of the Garton-Daniels Electric Company. Besides representing this company, Mr. Garton will also represent the Pittsburg Steel Hollow-Ware Company, Massachusetts Chemical Company, and other Eastern manufacturers. It is Mr. Garton's intention to devote himself to electrical railway supplies in general, but states that he will not give any attention to minor supplies or repair parts. Mr. Garton is a stockholder in the Raster Carbon Rheostat Company, as well as consulting engineer o. the same concern.

Automatic Circuit Breakers.—The Ward Leonard Electric Company, Bronxville, N. Y., has received a flattering testimonial from the Vance Electric Company, 136 Liberty Street, New York, on the merits of their circuit breaker. The latter states that for months past a 300-ampere automatic circuit breaker has been in use under peculiarly exacting conditions, and its performance leaves nothing to be desired, and adds: "I am well acquaintance with the various types of automatic circuit breakers, and have no hesitation in saying that your circuit breaker is the best now on the market. Your circuit breaker referred to above has been called upon to operate scores of times, and its performance has been perfect."

The Mica Insulator Company, of 218 Water street, New York, and 117-119 Lake Street, Chicago ,and 12 Camomile Street, London, reports a ..eavy increase in the volume of business. Many of the large manufacturers are using its "Micanite" segments in the construction of their generators and motors exclusively. The company has made many valuable improvements in its well known insulation, "Micanite," and are turning out a very fine commutator segment. They would be pleased

The Belknap Motor Co.
OF PORTLAND, MAINE,

are very busy in the manufacture of Chapman Voltage Regulators; about ¼ of their entire force is devoted to this work alone. Orders have recently been received from Bath (N. Y.) Illuminating Co., New Haven Electric Light Co.; Potomac Electric Light Co.. (third one ordered within few months). Northern Electric Light Co., Philadelphia; Middletown (Conn.) Electric Light Co., three regualtors. Pawtucket R. I. Electric Co.; Mutual Electric Light Co., St. Antonio, Tex.; Mt. Morris Electric Co., New York City, (two) recent shipments of Chapman Regulators have been made, (2) Johnstown, Pa.; Electric Co., Stockton, Cal., Gas & Electric Co., B. C.; Smelting & Refining Co., Trail, B. C.; People's Electric Co., Orange, N. J.; Thomas Oakes & Co., Bloomfield, N. J.; Clute Bros., Cohoes, N. Y.; H. T. Cushman Mfg. Co., North Bennington, Vt.; Lebanon (N. H.) Electric Co.; Haverhill (Mass.) Electric Co., &c., &c. The sale of Motors and Dynamos manufactured by this company is lively at the present time, their New York and Boston representatives, Brewster Eng. Co, 27 Thames Bldg., and the L. I. Fletcher Co., Boston, are hustlers and no mistake. About 200 H. P. in motors having been received from Brewster Eng. Co. since Jan. 1st, and a similar amount from L. I. Fletcher Co., more than 40 machines being sold since Sept. 25th by the latter company.



KEYSTONE ELECTRICAL INSTRUMENT CO.
Ground Detectors and Polarity Indicators
SWITCHBOARD AND PORTABLE INSTRUMENTS
901 Montgomery Ave.
PHILADELPHIA
New York: 15 Cortlandt St
Chicago
1440 Monadnock Block

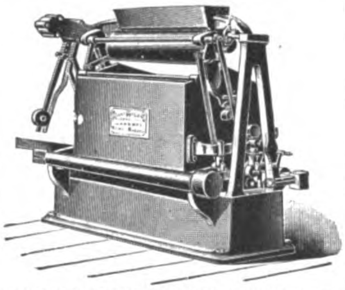
to send a set of segments for any of the smaller machines, as sample, to electrical manufacturers or repair concerns who may make application. "M-I-C" friction tape and "Empire" Cloth are also meeting with a large sale. They are used for the winding of fields and armature coils, and furnish the highest possible grade of insulation.

The W. S. Hill Electric Company, New Bedford, Mass., is now doing more than double the business than at this period last year. Some of its recent work is a switchboard for the Manhattan State Hospital, Ward's Island, N. Y. This is a white marble board 24 feet long by 8 feet high. The same company has recently built a white marble board about half this size for the Long Island State Hospital, at King's Park, L. I. One of the finest boards ever built by this company was recently completed for Houghton & Dutton, Boston. Although not so large as those above mentioned, it is certainly a model of effective switchboard construction, and for a board carrying so many different circuits the back of the board is remarkably free from the mass of wire usually found on a board of this kind, owing to the very neat and simple but systematic bus bar arrangement.

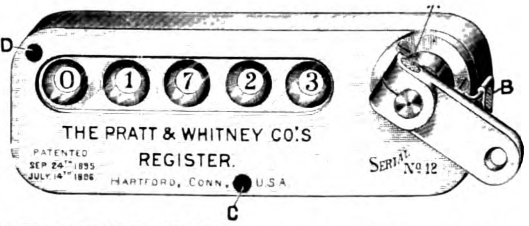
The Dearborn Drug & Chemical Co., oil and water chemists, Rialto Building, Chicago, has recently been incorporated for $250,000. This concern has just opened an office at 408 Security Building, St. Louis, Mo., which is in charge of Mr. Chas. Standfield, manager. Mr. Standfield is a regular graduate in pharmacy, also a thorough and efficient chemist, and is considered by the Dearborn Drug & Chemical Co. one of its most able men. Mr. Standfield is becoming rapidly acquainted with St. Louis institutions, and reports that the outlook in his territory is a very promising one. The Dearborn Drug & Chemical Co. already has a large trade in St. Louis and contiguous territory, many of the most important steam plants being users of the Dearborn compounds. Mr. W. H. Edgar states that the Dearborn Company did over 30 per cent. more business in 1897 than in the previous year, and he is looking for a decided increase over this for 1898.

Transformers.—The New York and Ohio Company, of Warren, Ohio, well known as makers of the Packard lamps and transformers, has for some time past been developing a new series of transformers which is now ready for the market. These will be known as the Packard Model '98. It is claimed that these transformers are fully equal and in some respects superior to any in commercial use. Particular claims are made regarding regulation, a point in transformer design which in the endeavor to obtain an exceedingly low core loss has been too often considered of secondary importance. The New York and Ohio Company has secured the services of Mr. H. W. Wiswell, who for several years has been connected with the transformer department of one of the largest manufacturers of this apparatus in the world. Mr. Wiswell's comparatively long experience in this particular branch especially fits him for his new duties. The New York office has been established at No. 1 Broadway, under the personal supervision of Mr. J. W. Peale, president of the company, who assisted by an efficient force will handle the Eastern business.

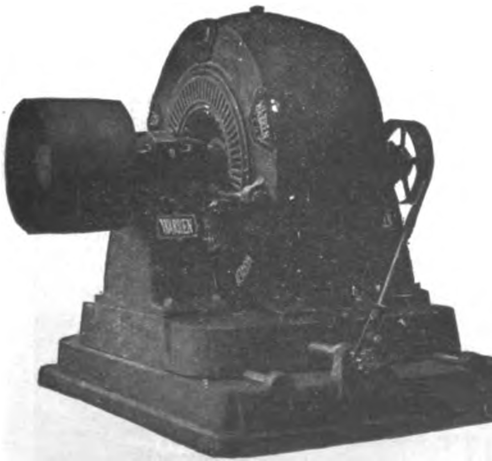
Walker Apparatus.—The Standard Light & Power Company, of Dallas, Tex., has placed an order with the Walker Company for two alternators, one of 225 and the other of 325-k.w. capacity. They are to be direct connected to "Erie" engines, and are designed to run at 125 revolutions per minute. The machines will generate 2-phase currents at a frequency of 60. In addition to these the Walker Company will furnish them with two direct connected railway generators of 225 and 325-k.w. capacity, respectively. The alternating generators of 250-k.w. capacity each are being built for the North River Electric Light & Power Co., of New York City. They are to be of the belted type. Townsend, Reed & Co., of St. Louis, have purchased for the St. Louis, Belleville & Suburban Electric Railway two 200-k.w. direct connected Walker railway generators, besides eight double 10-S railway equipment with "S" controllers. On the other side of the Atlantic, the Glasgow municipal tramway will place a number of Walker motors on its cars at an early date, while the Electric Railway of Alexandria, Egypt, will increase its present Walker plant by the addition of one 150-k.w. belted generator with switchboard, and four double 3-N equipments.



HIGH CLASS MACHINE TOOLS
for Machine Shops and General Metal Finishing Use.
Machines, Fixtures, Small Tools and Gauges for the manufacture on the interchangeable plan of Guns, Sewing Machines, Typewriters, Cash Registers, Bicycle Parts, etc.
Brass Finishing Machinery.
Reliable Counting Registers, Standard Measuring and Testing Machines.
Drop Forging Machinery: United States Standard Threading Machines and appliances.
Milling Cutters, Combination Lathe Chucks.
AUTOMATIC WEIGHING MACHINES for accurately weighing coal and all material of a uniform size handled for storage and distribution.
Lathes, Planers, Shapers, Drilling and Milling Machines for Tool Room use.
Bar Iron Limit Gauges, useful to protect the buyer of bolt iron against the delivery of material of sizes unsuitable for use without changing dies for heading or threading and of excessive weight.
Brigg's Standard Pipe Thread Gauges, useful for testing pipe and fittings to insure their delivery in condition for connection without rethreading when ordered to said gauges.

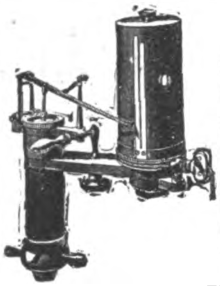


The PRATT & WHITNEY CO. Hartford, Conn., U. S. A.
CHICAGO: 42 So. Clinton St.
BOSTON: 144 Pearl Street,
NEW YORK: 123 Liberty St.
Buck & Hickman, 280 Whitechapel Rd. London, England,
Fenwick Freres & Co., 21 Rue Martel, Paris, France.



WARREN ALTERNATOR

SCHEEFFER WATTMETERS
SCHEEFFER TRANSFORMERS
PARAGON ARC LAMPS
Complete Alternating Current Equipments.
H. B. COHO & CO.
Broadway and Ann Street,
ST. PAUL BUILDING, NEW YORK.
EDDY DYNAMOS
EDDY MOTORS
CROWN BRUSHES



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made, or
special price
for cash.
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in your
ENGINE
and
OIL
in your
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prevented
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2-5 lb. or
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in price than
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Improved Robertson-Thompson Planimeters, Reducing Wheels, 3 Way and Elbow Cocks, Shaking Grate Bars, Waste Oil Filters, Exhaust Heads. | **Jas. L. Robertson & Sons,** 208 FULTON ST., N. Y. 12 Pearl St., BOSTON.

THE W. S. HILL ELECTRIC CO.,

MANUFACTURERS OF .. ..

THE LARGEST AND
FINEST LINE OF .. ..

SWITCHES for all uses,
SWITCH BOARDS,
DISTRIBUTING BOARDS,
JUNCTION BOXES,
Other Electrical Specialties.

NEW BEDFORD, - MASS., U. S. A.

TO EARN MORE LEARN MORE.

Our correspondence courses in Electrical, Mechanical and Steam Engineering will help you to do both. Our school is conducted by professional engineers of high standing and indorsed by educators and technical men. It has courses for those just able to read and write and for graduates of technical schools. Our catalogue, sent free on application, tells all about it. INSTITUTE FOR HOME STUDY OF ENGINEERING, 224 Seneca Street, Cleveland, O.

A TECHNICAL EDUCATION
10 CENTS A WEEK

THE new installment plan of The International Correspondence Schools, Scranton, Pa.—the first and most successful institution teaching technical subjects by mail—places an education within the reach of all. A first payment of $2.00 only is required on enrolling, the balance being payable at the rate of $2.00 a month. The charges for tuition are moderate and include all necessary textbooks.

The Electrical Power and Lighting Scholarship is a thorough course of instruction in the installation, care and operation of electric light, power and railway plants, designed to meet the wants of busy men who wish to put into practice as soon as possible the information they acquire.

The Mechanical-Electrical Scholarship includes instruction in mechanical and electrical engineering and is intended especially for those who wish to become designers of electrical machinery.

Our 48 courses of study include Steam Engineering, Mechanical Drawing, Machine Design, Civil Engineering, Shorthand, Bookkeeping and English Branches.

Write for free circular, stating subject in which you are interested.

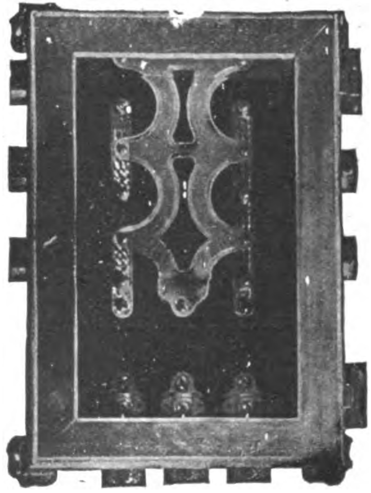
The International
Correspondence Schools,
Box 1025. SCRANTON, PA.

Standard Steel Armored, Slate Lined, Self Contained
Panel and Distributing Boxes
For any number of Circuits, with or without Switches, two or three wire system.

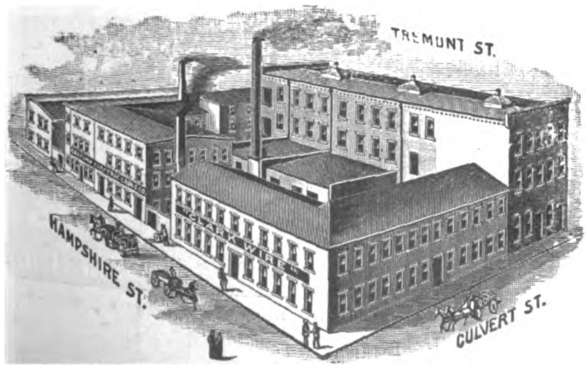
MAIN FEEDER AND TERMINAL BOXES,
For buildings, marine or underground work.

Steel Drawn Switch, Wall and Ceiling Outlet Boxes, threaded for Conduit and provided with Water-tight Cover,
For either brass or iron armored conduit, switches and switchboards.

The Bossert Electric Construction Company,
UTICA, N. Y.



"CLARK WIRE"
TRADE MARK.


TREMUNT ST.
HAMPSHIRE ST.
CULVERT ST.

THE "CLARK" WIRE

In a Letter from the Inspector of the Boston Fire Underwriters' Union, he states:

"A Thoroughly Reliable and Desirable Wire in Every Respect."

For Switchboard, Railway and Motor use, we make all sizes of Stranded and Flexible Wire and Cables with Clark's Insulation.

The Clark Wire has been before the public and in use for the past nine years, and has met with universal favor. Thousands of miles of this wire have been sold, and are in use throughout the United States and foreign countries, and the demand for it is constantly increasing, because it always gives perfect satisfaction.

The Rubber used in insulating our Wires and Cables is especially chemically prepared and will not deteriorate, oxidize or crack and will remain flexible in extreme cold weather, and is not affected by heat.

We guarantee our Insulation wherever used, Ærial, Underground or Submarine, and our net prices are as low, if not lower, than any other first-class Insulated Wire.

We shall be pleased to mail catalogues with terms and discounts for quantities.

EASTERN ELECTRIC CABLE CO.

HENRY A. CLARK, Treas. & Gen'l Mgr.
HERBERT H. EUSTIS, Pres. & Electrician.

61-63 Hampshire St., Boston, Mass.
SEND FOR CATALOGUE.

WANTED TO PURCHASE.

WANTED—A first-class, second hand, X-ray apparatus. Address, W. A. Price, D. D. S., 2238 Euclid Ave., Cleveland, Ohio.

WANTED—Mixed lot of about one thousand, 50 and 100 volt direct and alternating current fan motors. Address, THEO. K. JACKSON, Ann Arbor, Mich.

SITUATIONS WANTED.

WANTED—By a competent young man, a situation as telephone inspector or station lineman. Has had five years' experience. Would go anywhere. Can furnish best of references. Address, "R. J. M," care of AMERICAN ELECTRICIAN, New York.

WANTED—A young man with six years' practical experience, would like position as superintendent of a central station. Can furnish best of references. Good reason for wishing to make a change. Address, "Superintendent," care of AMERICAN ELECTRICIAN, New York.

WANTED—Situation by a competent man, now in charge of electric railway; thoroughly understands line work, trucks and motors, G. E. and Westinghouse winding and lamp wiring. Southern or western states preferred. Can furnish best of references. Address, "B. D.," care of AMERICAN ELECTRICIAN, New York.

WANTED—Position by an A1 practical man capable to install machinery. Now employed as station man at a splendid electric light and water plant. Salary moderate. Good reference for nine years' experience. Or would lease a plant in some live town. ENGINEER AND ELECTRICIAN, care of AMERICAN ELECTRICIAN, New York.

WANTED—Young man desires position in office or plant of a Light and Water Co. Has worked in a lamp factory and understands testing lamps. Desires to prepare for superintendent. Pay no object. Not afraid of hard work. Understands bookkeeping. Best references. Address, "G. T. A.," care of AMERICAN ELECTRICIAN, New York.

WANTED—A young married man, 26 years of age, would like position where there is good chance for advancement. Has had seven years practical experience as all-around man in large power plant. Can do line work, wiring, and arc lamp repair work. Understands handling Alternating Current working, and winding transformers and meters. Is also acquainted with work connected with the steam end of plant. Knows something of the office work connected with a plant, and has had extended experience in collecting "bad bills." Has position at present but prospects are not satisfactory. Can furnish best of references from previous employers. Address, "X. Y. Z.," care of AMERICAN ELECTRICIAN, New York.

ENGINEERS' AND MACHINISTS' POCKET BOOK.

PRICE: In Cloth $1, in Leather $1.25, 381 Pages. 64 Illustrations.

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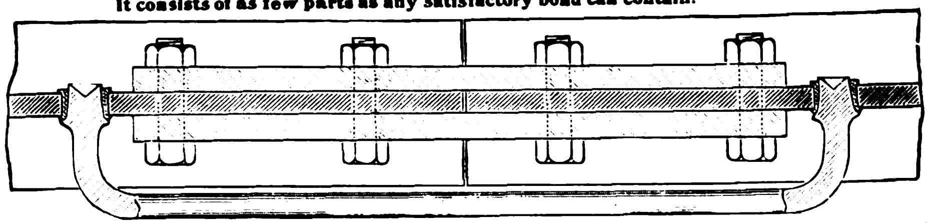

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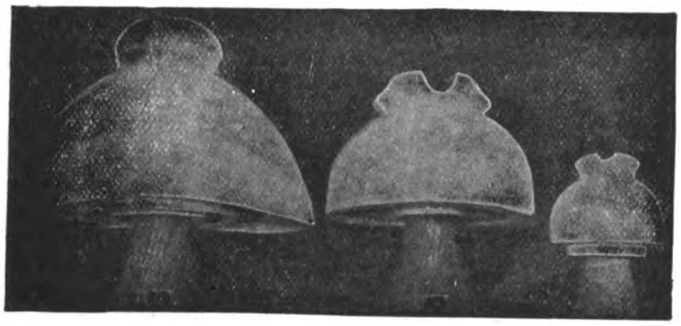

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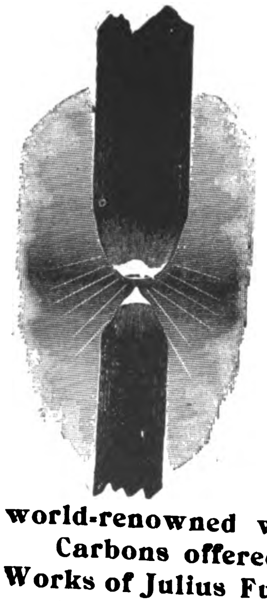

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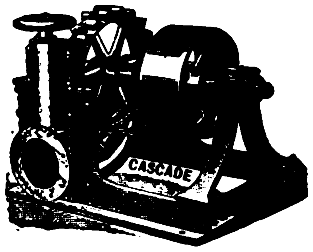

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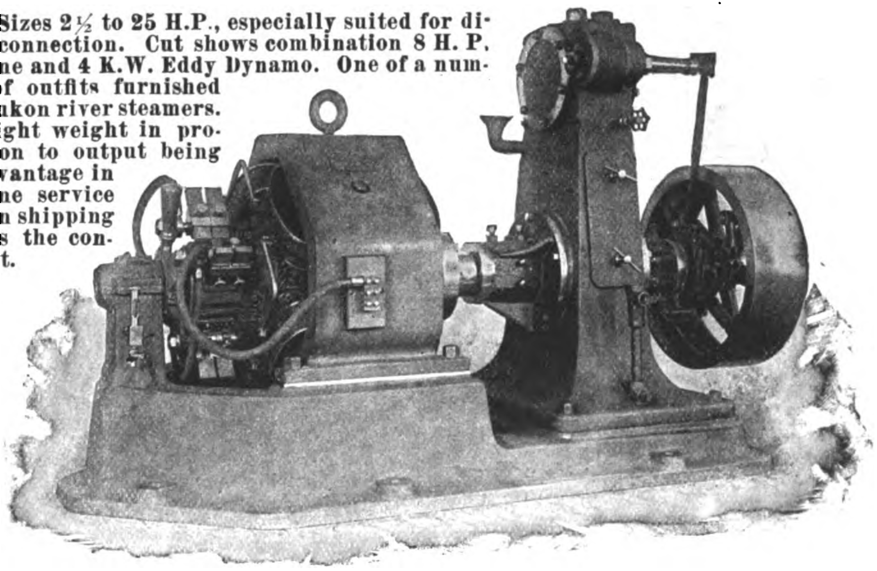

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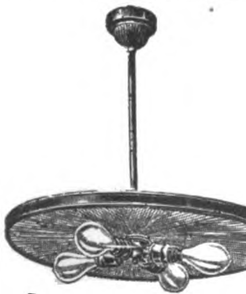

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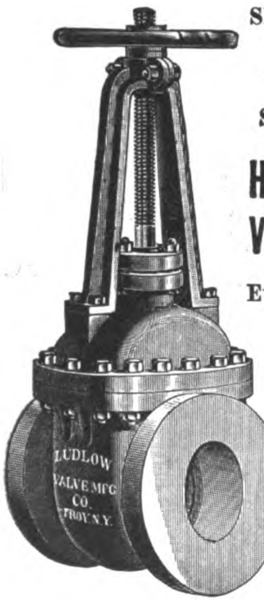
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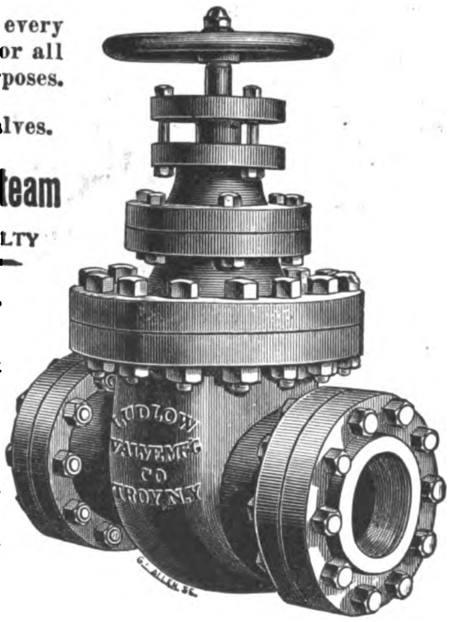
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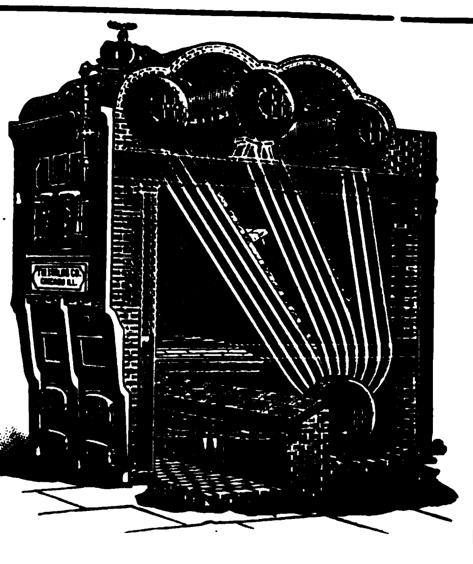

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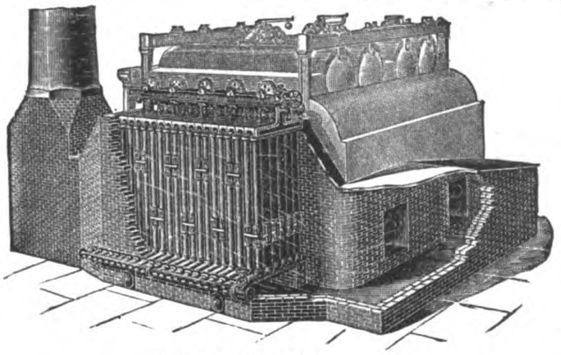

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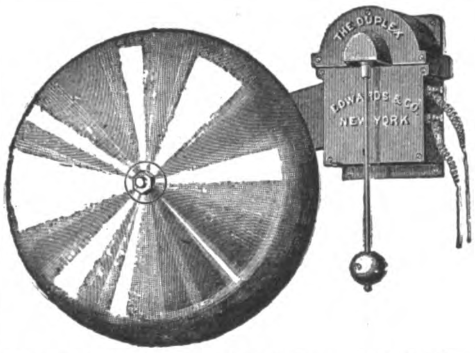

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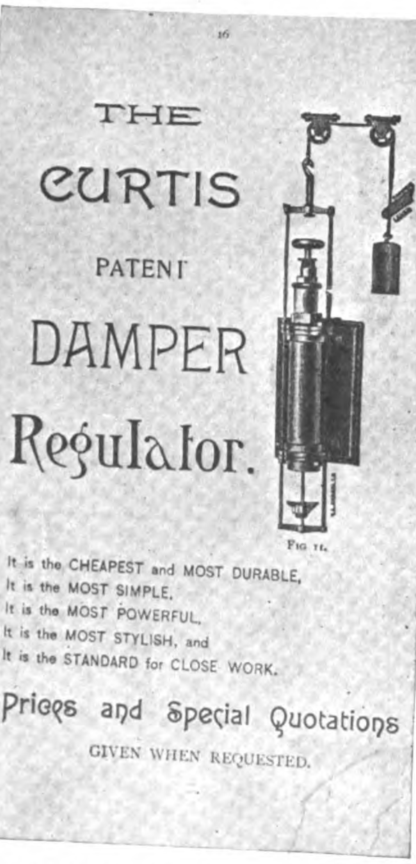

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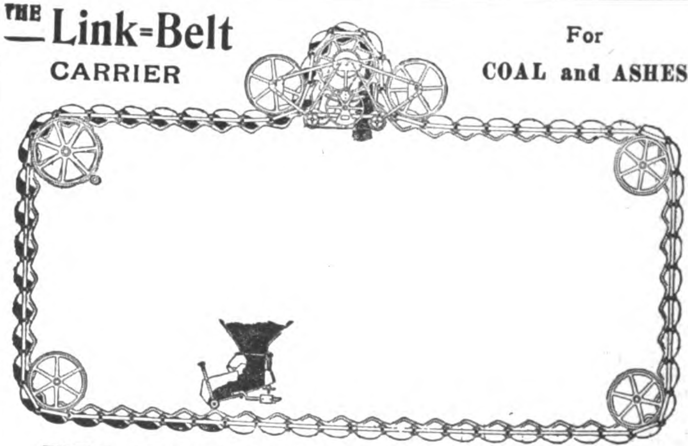

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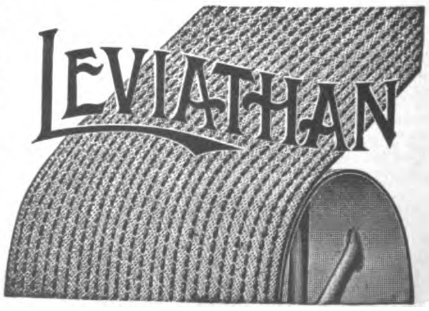

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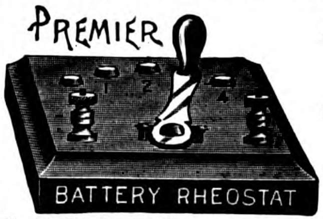

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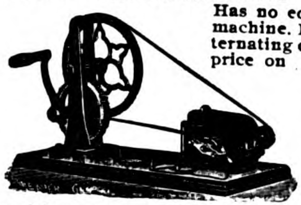

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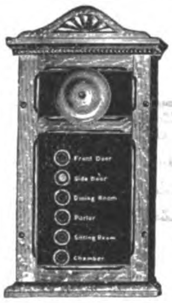

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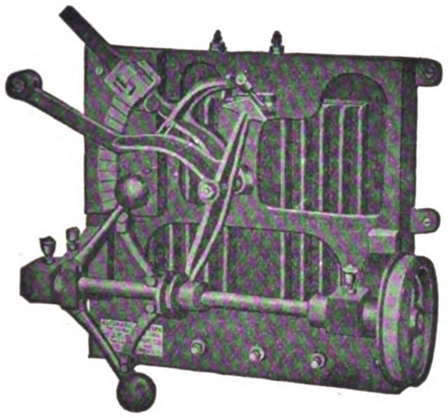

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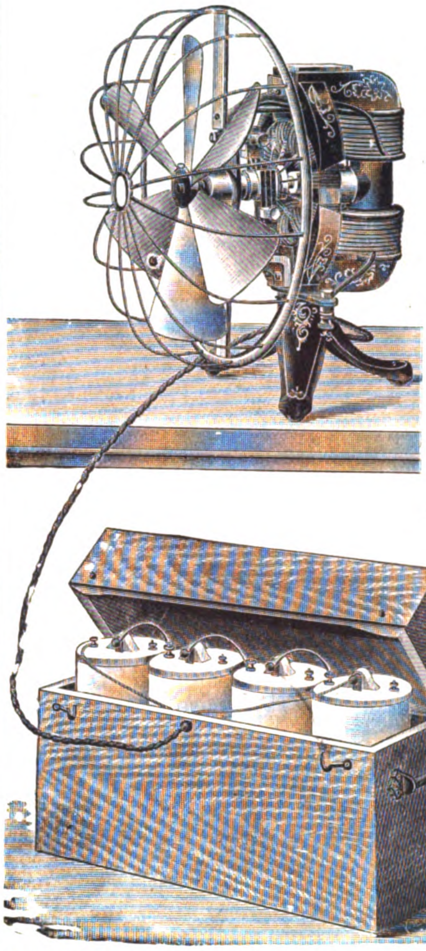

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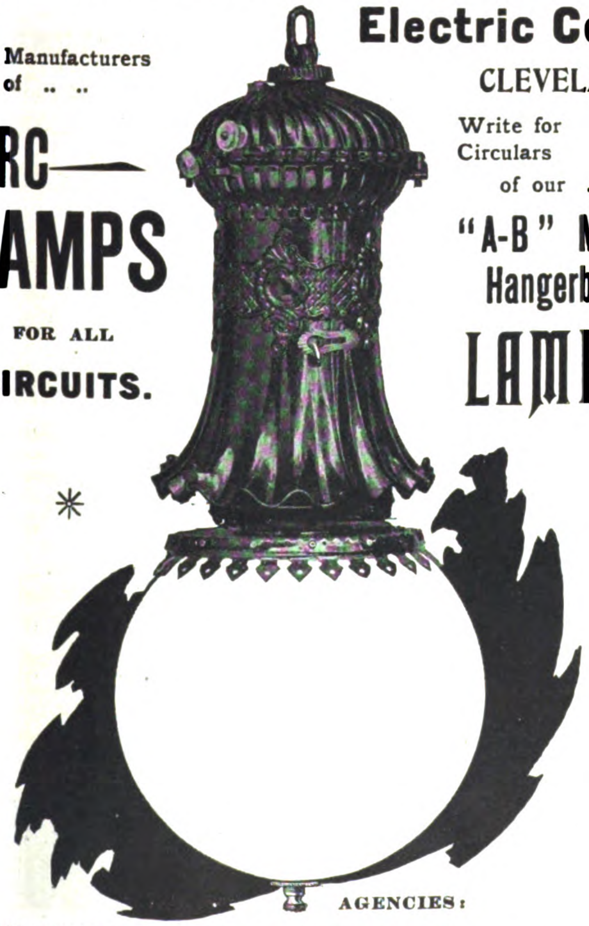

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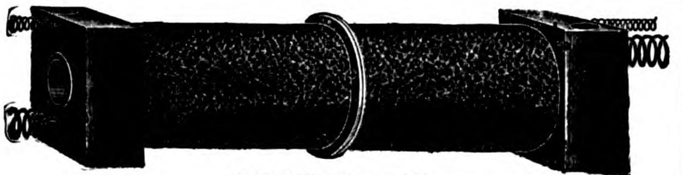

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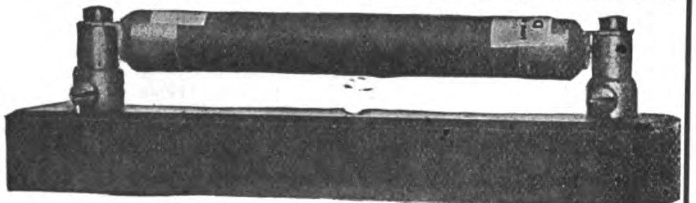

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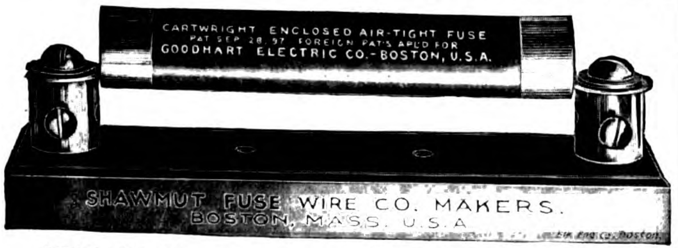
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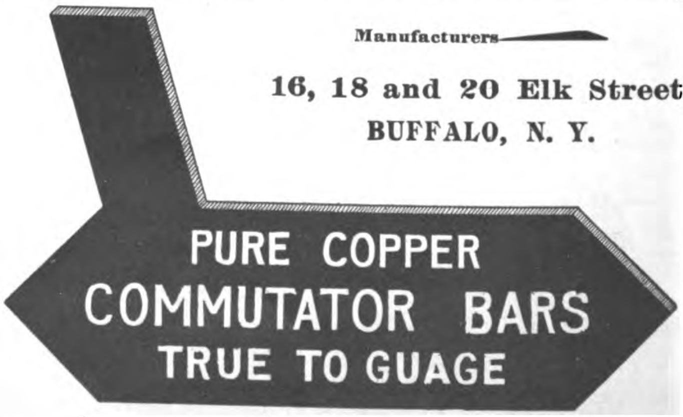

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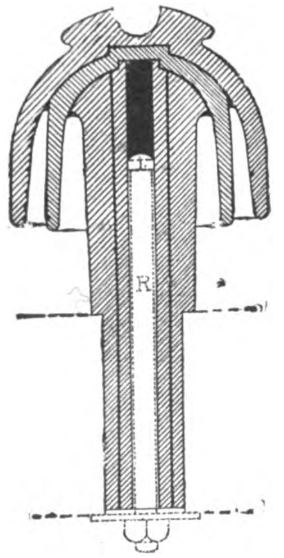

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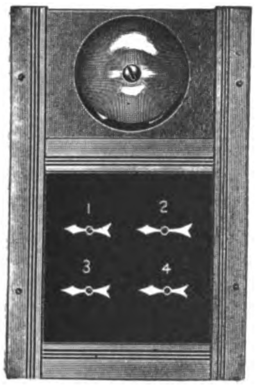

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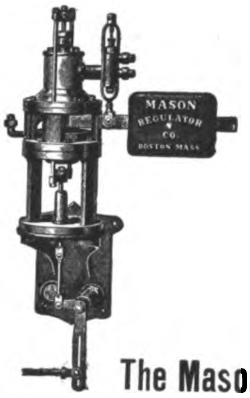

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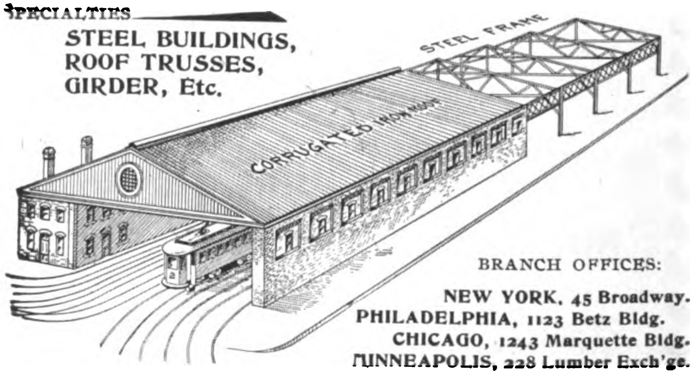

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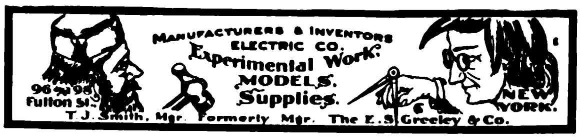

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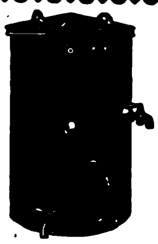

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American Electrician.

Vol. X. New York, April, 1898. No. 4.

THE DOLGEVILLE (N. Y.) WATER-POWER ELECTRIC LIGHT AND POWER PLANT.

BY E. A. GRISSINGER.

ANOTHER substantial impetus was given to the generation of electrical energy through the medium of water power, when on Jan. 15 of the current year the Dolgeville Electric Light & Power Company put in operation its excellent and modern plant at High Falls, N. Y., on what is now known as the Auskerada River. That the opening day had been looked forward to for a long time was evidenced by the large number of people present on the occasion. Through the columns of other papers, the social and literary character of the gathering, subsequent banquet, etc., furnished interesting reading; and the purpose of this paper is to deal more particularly with the organization of, and certain technical details relating to, the installation.

The Dolgeville Electric Light & Power Company was organized and incorporated in December, 1891. The capital stock was fixed at $25,000. Early in 1892 some direct-current apparatus was installed, furnishing light and power in small units. This plant has always been operated by water power under 22 ft. of head. The calls upon the company for electrical energy expanded to such an extent that, previous to the opening of the new power, the company was operating the following machines: Two 50-k.w., 500-volt, direct current; one 90-k.w., 500-volt, direct current; two 45-k.w., 110-volt, direct current; one 20-k.w., 110-volt, direct current of General Electric make; and one 7-kw., direct current, type "Z," Edison generator, bearing the date of 1879 and numbered "No. 2."

The machines of 110-volt potential furnished current for the commercial lighting circuits. Those of 500 volts were used for power purposes, and also furnished current for street lighting. The latter was accomplished by clusters of five lamps in

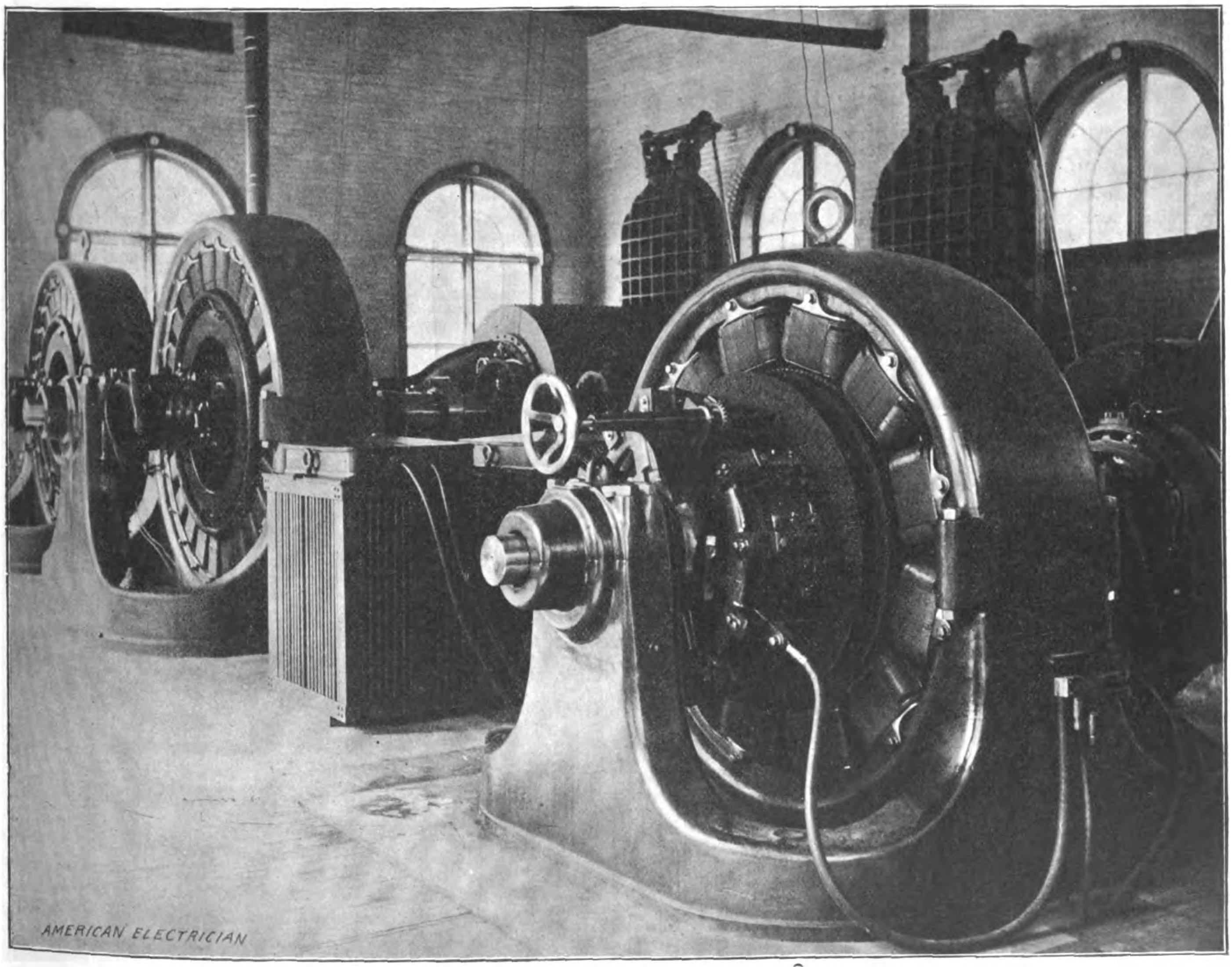


FIG. 1.—GENERAL VIEW OF THE PLANT.

series across the 500-volt mains. About forty such clusters were in use.

One pair of 35-in. horizontal Victor turbines, running at 168 r.p.m., and developing 480 h.p. under 22 ft. of head, furnished the power necessary to operate the plant.

The business of the company had outgrown its narrow confines. The directors were thoroughly appreciative of rapid strides made in the field of power transmission, and recognizing their own peculiar and great advantages for water power development, decided early last year to increase the capital stock of the company and proceed with development on a modern scale. Accordingly a contract was made in the early spring with the Stilwell-Bierce & Smith-Vaile Company for the hydraulic development, which company supplied all plans and built the plant complete up to the generators. Mr. A. C. Rice, general superintendent and engineer of the company, being in direct charge of the work. In July a contract was made with the Westinghouse Electric & Manufacturing Company for the electrical equipment.

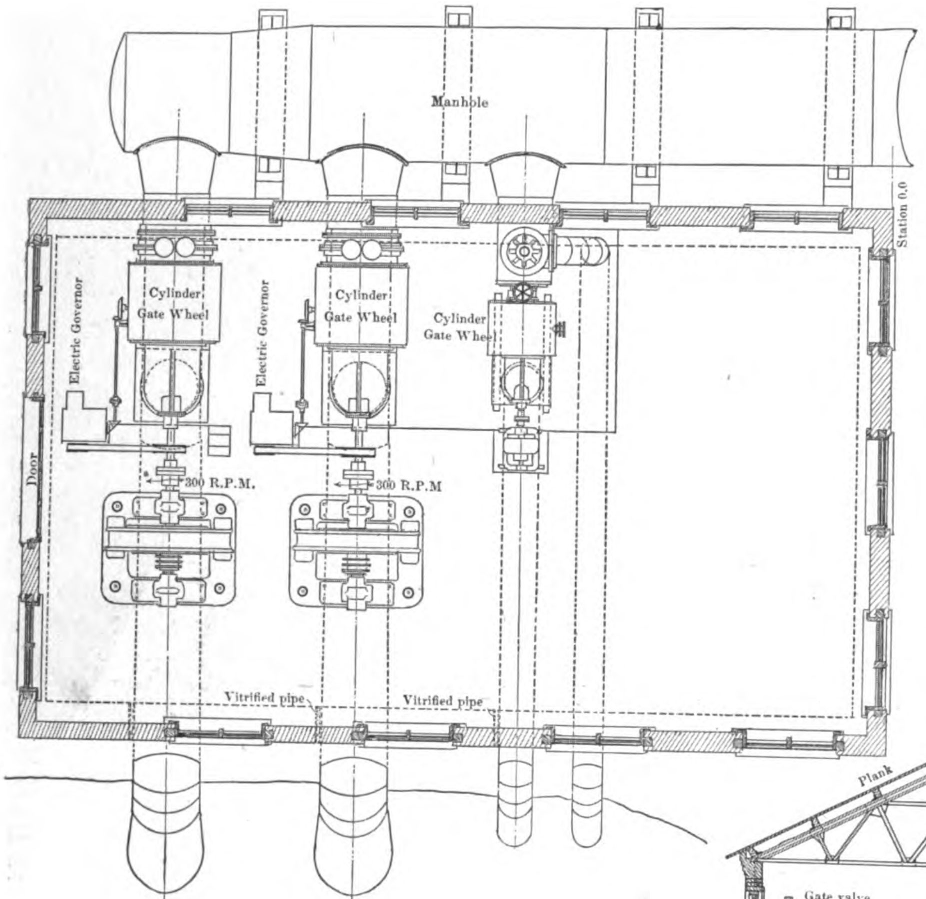
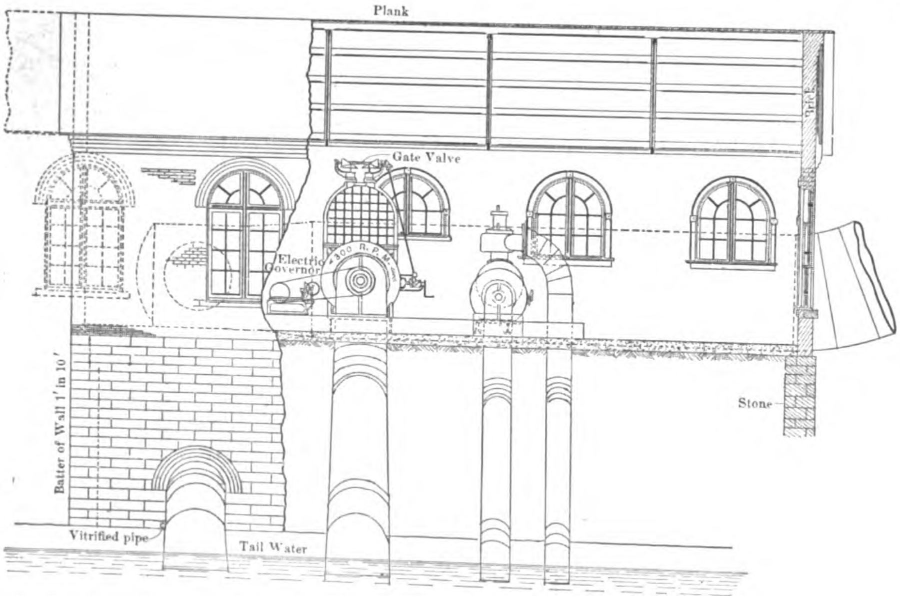

Manhole
Station 0.0
Electric Governor
Cylinder Gate Wheel
Electric Governor
Cylinder Gate Wheel
Cylinder Gate Wheel
Door
300 R.P.M.
300 R.P.M.
Vitrified pipe
Vitrified pipe

FIG. 2.—PLAN OF POWER HOUSE.


Plank
Brick
Gate Valve
Electric Governor
300 R.P.M.
Stone
Batter of Wall 1' in 10'
Vitrified pipe
Tail Water

American Elect.

FIG. 4.—PARTIAL LONGITUDINAL SECTION AND SIDE ELEVATION OF POWER HOUSE.

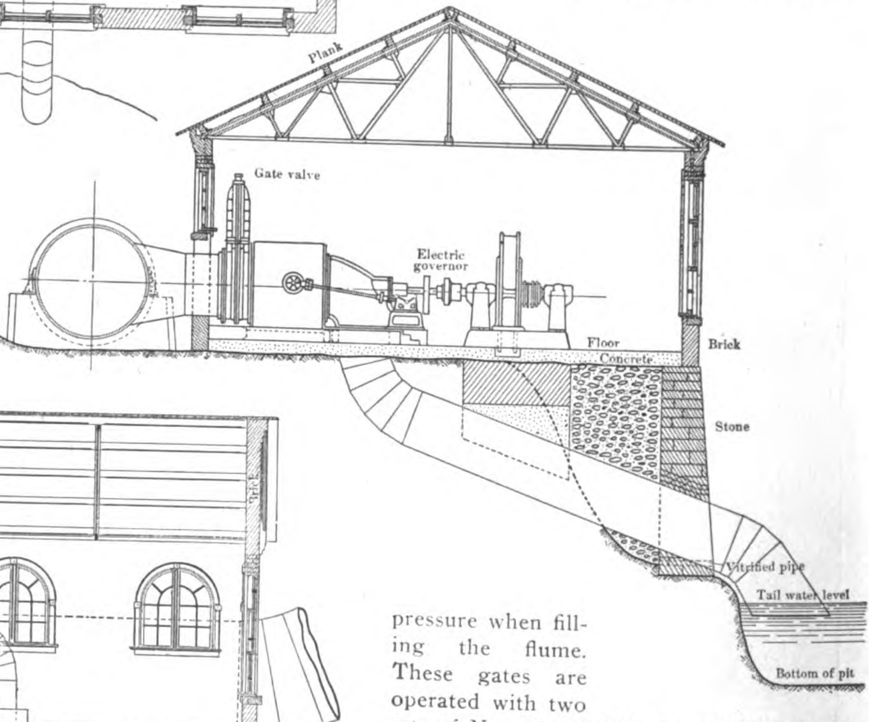

Plank
Gate valve
Electric governor
Floor
Concrete
Brick
Stone
Vitrified pipe
Tail water level
Bottom of pit

FIG. 3.—CROSS-SECTION OF POWER HOUSE.

The Dam and Flume.—As soon as the weather permitted it, work was begun on the construction of the dam. This is a good example of masonry construction. The height at the spillway is 20 ft., and each abutment 6 ft. higher, the total length being about 195 ft. The width at the top is 7 ft., and at the bottom 26 ft. The upstream side of the dam is perpendicular, the down-stream side affording a good apron, the lower curve drawn to a radius of 10 ft. Limestone was used in the construction, the face stones coming from Ingham's Mills, 2 miles below the power site. The Glens Falls Portland Cement Company furnished the cement, which was their Victor brand. In mixing for use, one part was used with four parts of sand. Fig. 5 is a view of the dam, and Figs. 10, 11 and 12 show sections through the head gate, waste gate and main portion, respectively.

The westerly abutment contains a flush gate 4 ft. x 6 ft., to which is attached one set of No. 6 waste gate irons for operating the same. Beside this waste gate is the head gate, 12 ft. square in two sections, being fitted with a pass gate to relieve the pressure when filling the flume. These gates are operated with two sets of No. 2 head gate irons, as made by the Stilwell-Bierce Company. The steel flume extends from the head gate to the power house, 520 ft. away. This flume is 10 ft. in diameter, and is made of ¼-in. steel plate, all longitudinal seams being double riveted. Just outside the dam is a vent pipe, which will assist toward relieving the flume from any sudden strains. Masonry piers at intervals of 20 ft. furnish the necessary supports for the flume. The latter has two curves in its descent to the power house level, and was made of sufficient diameter to provide for the ultimate development of this plant. The flume terminates in the customary steel forebay used in connection with horizontal wheels. Fig. 6 gives a general view of the dam, steel flume and power house.

The Power House.—The power house is of brick construction, with its foundations and those of the machinery carried to bed rock. The building is 46 ft. x 64 ft. x 16 ft. to the roof trusses, which latter are of steel construction, four in number. The draught tubes from the wheels are arched over with substantial masonry arches, and the filling about these and the foundations of the machinery consists of broken stone and hydraulic cement. The whole is topped with a 6-in. layer of concrete, constituting the finished floor of the building. Telephone communication extends from the station to the village, and will have connections ultimately to all points where the power will be used. Fig. 2 is a plan of the building, showing the arrangement of the machinery. The switchboard has been placed at the right end of the building toward the dam. The power house is so situated and the excavations have been proceeded with in such a way as to permit of extensions longitudinally to the capacity of the plant, which will ultimately be 3600 h.p. From Fig. 3, showing a cross section of the station, it will be noted that the steel forebay is placed just outside and parallel to the building, extending the full length of same. Fig. 4 shows a partial longitudinal section and side elevation of the power house.

Hydraulic Equipment.—There are two 36-in. horizontal Victor turbines, each direct connected to one 450-k.w. two-phase Westinghouse generator. Each of these wheels will develop 600 h.p. at 300 r.p.m., under the working head of the water, which is 72 ft. They are mounted in cylindrical steel casings, discharging at the end downward through draught tubes, which latter, passing through the power house foundation, extend a few inches below the surface of tail water. Each wheel is supplied with a Giesler electro-mechanical governor, which gives satisfactory regulation. One of the wheels, with governor in the foreground, is shown in Fig. 7.

One exciter wheel, 15 ins. in diameter, has been installed, running at 375 r.p.m. and driving a 15-k.w., 110-volt multipolar exciter. As the load upon the exciter is approximately constant, no governing mechanism has been deemed essential. The gates at the larger wheels are operated through the medium of a double set of bevel gears and of the exciter wheel by means of an ordinary hand wheel. All of the turbines are of the cylinder gate pattern, the two larger ones being "Victor Specials."

From the supply main to the exciter wheel a relief pipe is tapped, which, by means of a suitable valve arrangement, permits of water being drawn from the flume when such procedure is deemed essential. The turbines run right-handed. The speed of the driving mechanism at the governors is 483 r.p.m. All of the construction pertaining to the hydraulic equipment is substantial and well made.

The Electric Equipment.—Fig. 1 gives a general view of all generators except the exciter. In the foreground will be noticed the rotary transformer of 250 k.w. capacity, to the left of which are two 450-k.w., two-phase alternating current Westinghouse generators, direct connected to the tur-

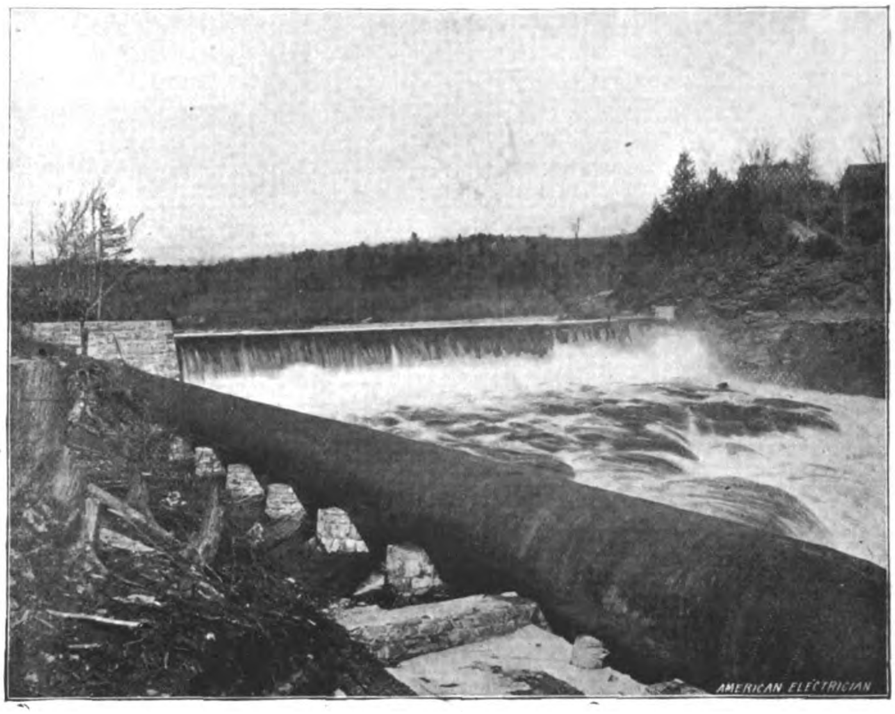


FIG. 5.—VIEW OF DAM AND FLUME.

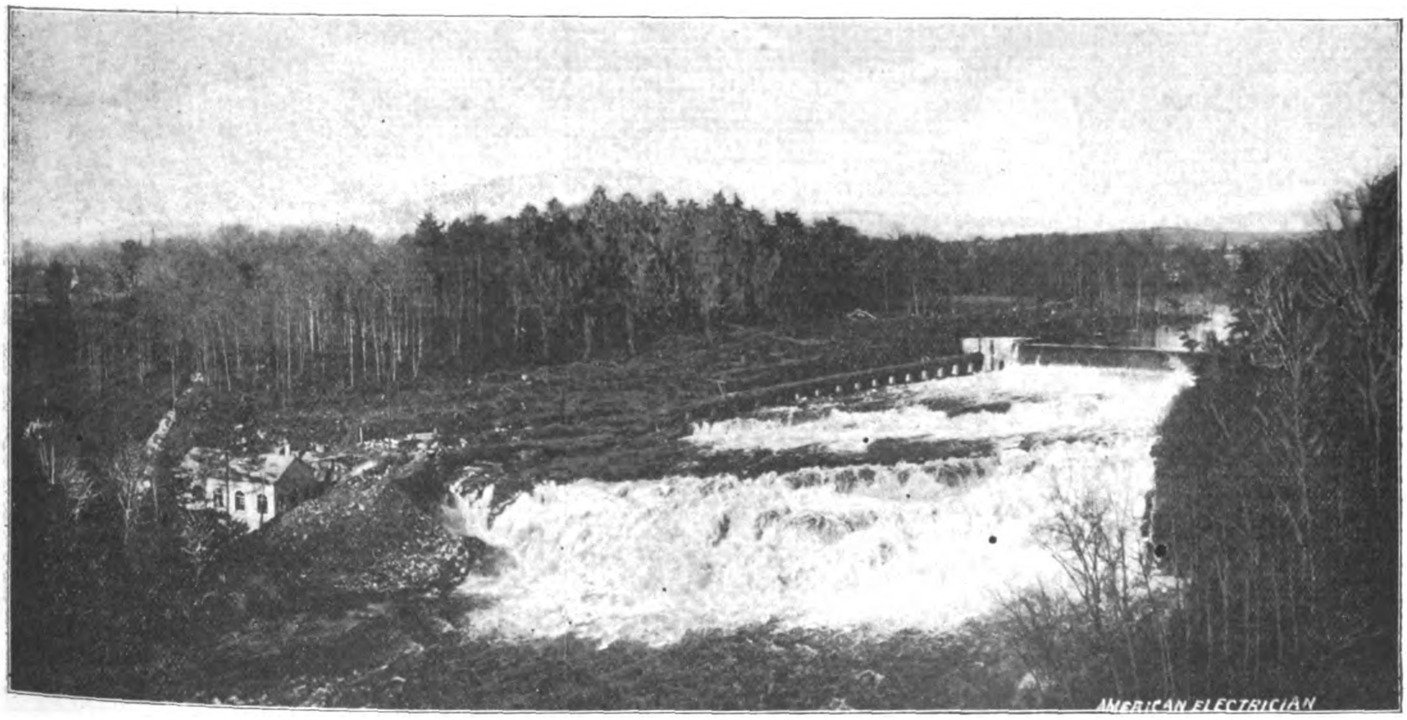


FIG. 6.—GENERAL VIEW OF DAM, FLUME AND POWER HOUSE.

bines by face couplings. The generators are of 2400 volts potential, and will deliver their rated output at 300 r.p.m. at 94 per cent efficiency under continuous service of any nature, no part showing a rise in temperature of more than 40 deg. C. above that of the surrounding atmosphere. The armatures are of the slotted type, wire wound; the frequency is 60 cycles, there being twenty-four poles.

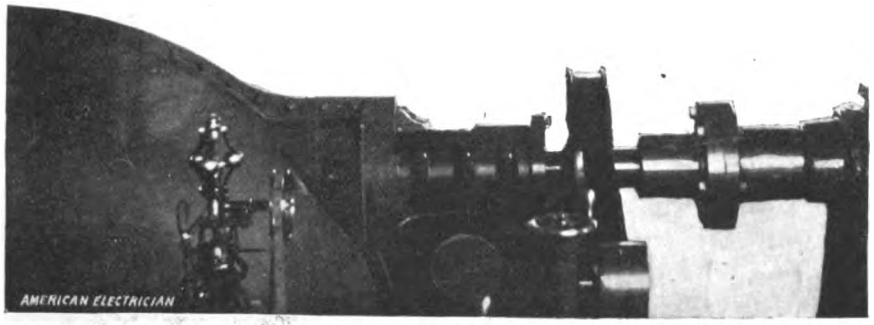


FIG. 7.—ONE OF THE TURBINES.

The field frames are cast from a special grade of iron, insuring high permeability. They present the usual characteristic of Westinghouse apparatus—that of beauty and symmetry in design. Laminated poles are used, insuring high efficiency, close regulation and cool running under trying conditions of service. The bearings are of liberal proportions, self-oiling, there being two oil rings to the bearing. The fields divide through the center in a horizontal plane, such being necessary in the direct-connected type of generator.

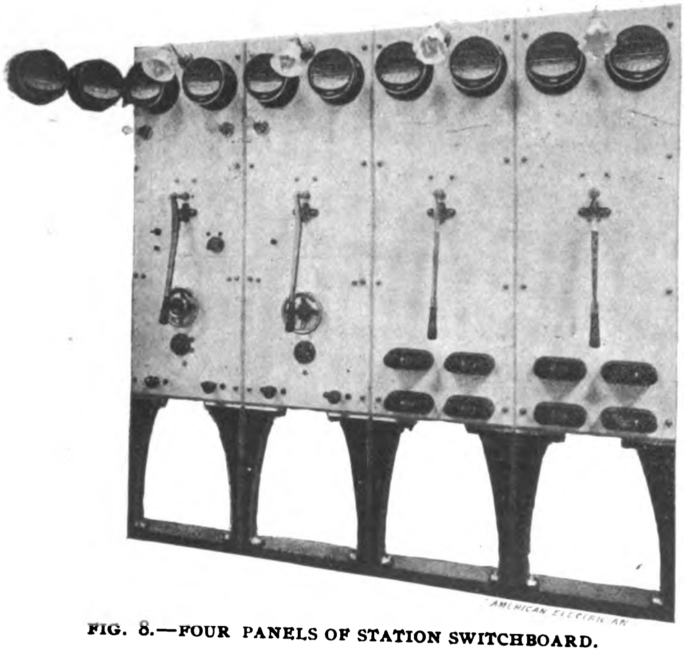


FIG. 8.—FOUR PANELS OF STATION SWITCHBOARD.

The armature core consists of a cast steel spider, having upon its periphery a number of projections, which are turned off to the proper radius, after which operation they are centered and carefully dovetailed upon a machine suitable for the purpose. The armature stampings, which are of specially annealed steel, are then manually built up on this spider, their projections fitting into the slots, dovetailed fashion. When the proper number of laminæ are obtained, they are forced in closer relation by pressure, and so retained by means of steel rings fastened together from each side of the core. Four collector rings are provided, which convey the current to the brushes, 93.7 amps. being the normal current per phase.

Four No. 1 wires carry the current from each alternator to the switchboard, and No. 4 wires convey the exciting current between switchboard, exciter and alternators.

The generators are securely fastened to the foundations by means of anchor bolts provided for the purpose, and are designed with such a factor of safety that they will withstand a speed equal to that of the wheels when traveling at the spouting velocity of the water under 72 ft. of head.

In view of the fact that there were a large number of direct current motors in use in Dolgeville, it was found necessary to provide a 250-k.w. rotary transformer. This machine delivers direct current at 600 volts potential, running as an alternating current motor, self excited, the fields having a compound winding. The speed of this machine is 600 r.p.m. On the direct current side there are twelve brush holder arms, two carbons to the arm. The carbon holders are of the swivel type, being a late design of the Westinghouse Company. The rocker arm is readily adjustable by means of a worm and bevel gear, which device renders the movement self-locking.

Bar winding is used on the armature, and is of the same general type as is found on the Westinghouse railway generators. The open type of winding and apertures in the armature core insure excellent ventilation.

For the purpose of starting the rotary and bringing it up to speed, a two-phase type "C" induction motor of the same general design as those largely in use at Buffalo and Niagara Falls, has its rotating secondary keyed to the shaft of the rotary. The primary of this motor rests upon a bracket fastened to the frame. Current for the induction motor and also for the alternating current end of the rotary is obtained from the alternators through a pair of static transformers, each of 125 k.w. capacity. These converters are the self-cooling oil type, and receive current at 2400 volts, transforming to any one of three e.m.fs., 405, 430 or 455. By this means any change in the direct-current power circuit by virtue of increased or decreased load can be met.

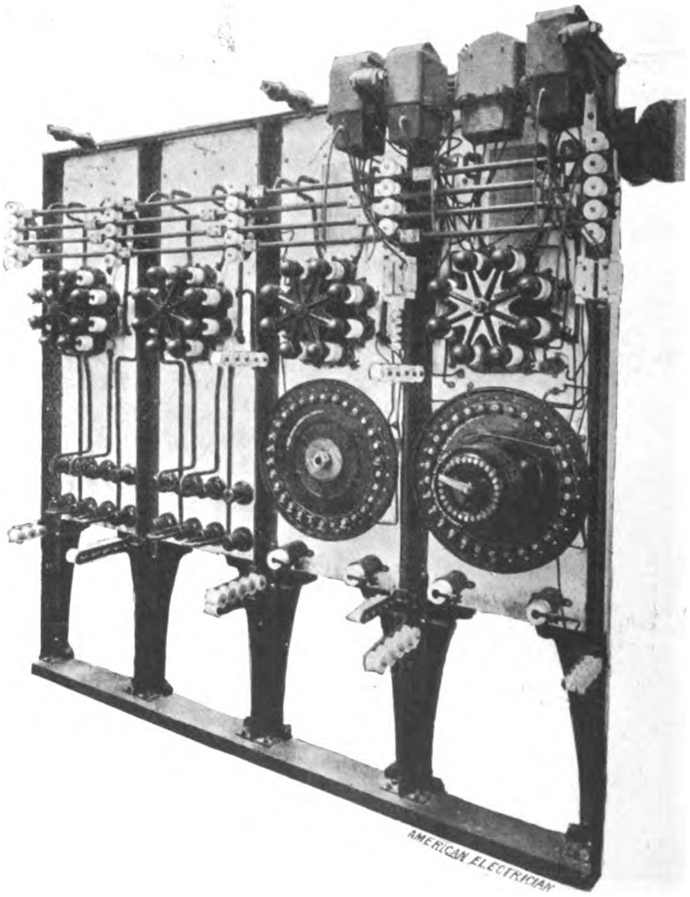


FIG. 9.—REAR VIEW OF ALTERNATING CURRENT PANELS.

Fig. 8 shows four panels of the station switchboard. The two panels at the left control the alternating current generators. Each panel is of Vermont marble, 65 ins. x 24 ins. x 2 ins. resting upon cast iron standards. Upon each generator panel is mounted a pair of ammeters of the round pattern, a pilot lamp, two field plugs, a four-pole, double-break plunger type switch and voltmeter receptacle. Panel No. 1 contains in addition one combination A. C. & D. C. rheostat, ground detector receptacle and push with lamps; panel No. 2 has synchronizing lamps and A. C. rheostat, the switchboard having been designed to operate the generators in multiple. Upon a swinging bracket to the side, one voltmeter for each generator is mounted. These are also of the round pattern, and have a range of 0 to 140 volts.

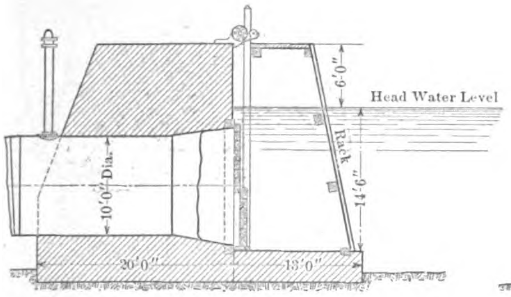


FIG. 10.—SECTION THROUGH HEAD GATE.

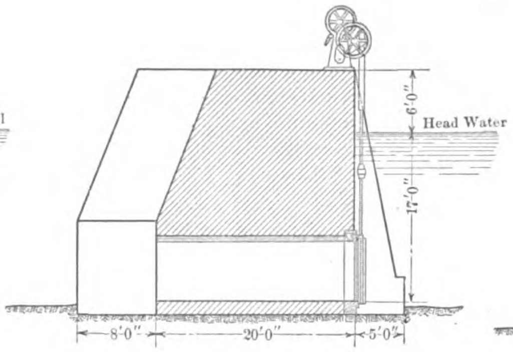
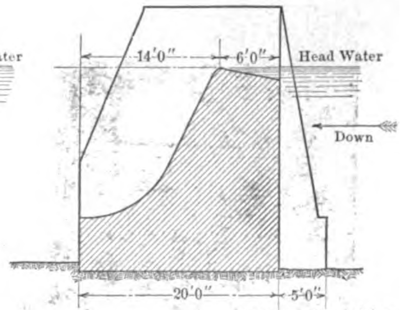


FIG. 11.—SECTION THROUGH WASTE GATE.



American Electrician

FIG. 12.—SECTION THROUGH BODY OF DAM

The feeder panels, of which there are two, each contain a pilot lamp, four-pole double-break, plunger type switch, four lignum vitæ fuse blocks, using aluminum fuses, and two ammeters of the round pattern. Special attention is called to this board on account of its neat appearance, simplicity for alternating current work, and the fact that there are no metal parts on its face which can be charged in any way by the current handled by it. The combination rheostat controls the exciter voltage and also the fields of the alternating current generator. The exciter rheostat is mounted directly on the back of the board, while the face plate only of the A. C. rheostat is so mounted while the rheostat proper stands upon the floor back of the board. This auxiliary piece of apparatus is of the ironclad type, built up of columns consisting of iron ribbon wound in coils with mica between the layers, each coil so formed having its own terminals admitting of any combination in series or parallel.

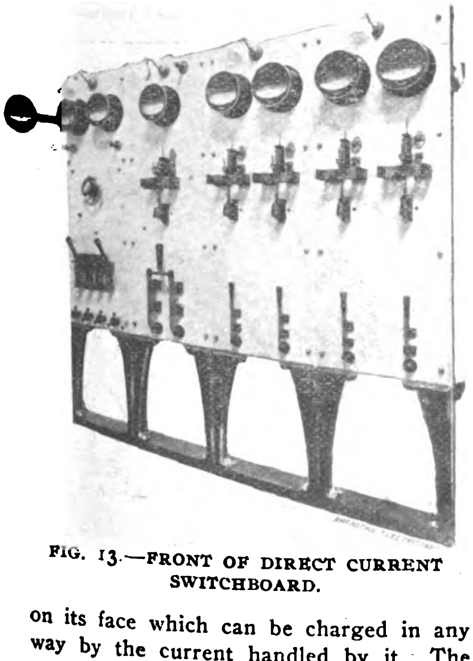


FIG. 13.—FRONT OF DIRECT CURRENT SWITCHBOARD.

Fig. 9 gives a rear view of the A. C. panels, showing the method of supporting the conductors. At the top of the board are the converters for use with the voltmeters and ground detectors.

The plunger type switch shows eight terminals. These are accounted for by the fact that the switch is four-pole, with two terminals or plunger receptacles connected in series in each leg of the two-phase circuit, making it a double-break switch. The breaking of a circuit in such a form of switch is caused by the arc blowing itself out through an aperture provided in the airtight chamber within which the plungers work. This type of switch, as perfected by the Westinghouse Company, successfully breaks its circuit when fully loaded, even though there be a heavy lagging current. They have added much in the way of facilities for handling power circuits using an alternating current.

Figs. 13 and 14 give a good idea of the front and rear of the direct-current board. This board is a continuation of the alternating current panels, each panel being of the same size. The first panel to the left is for controlling the rotary transformer. At the bottom of this panel are four plugs for throwing in the induction motor, thereby starting the rotary. Two lamps upon this panel indicate when the machine is at synchronous speed, at which time the four-pole quick-break switch is thrown, and the plugs withdrawn, relieving the small motor, which remains out of circuit. The hand wheel operates the field rheostat of the rotary. Two A. C. ammeters and a swinging D. C. voltmeter complete the rotary panel.

The second panel is the load panel for the D. C. end of the rotary, containing a double pole switch, circuit breaker and ammeter. The last two sections of this board represent feeder panels, each of two circuits of 200 amps. capacity. At present these feeder panels supply current to three independent circuits, each circuit of No. 0 wire. All leads between the switchboard, dynamo and transformers are carried beneath the floor in a brick lined conduit of ample size. They are supported upon porcelain insulators, attached to wooden cross-pieces, which latter are placed at intervals of 3 ft. This conduit will be covered with a glass plate 1 in. in thickness, and extending its entire length, thus keeping in view at all times the wiring of the circuits.

As previously stated, the original plant supplied current at 110 volts for commercial lighting. This system is now abandoned, and with some changes in the wiring, together with the necessary transformers, the A. C. generators are doing that work. One of the A. C. feeder panels is used for the purpose of controlling the lighting circuits. The remaining A. C. feeder panel will be used for the circuit going to the step-up transformers which will supply current to the transmission line for use in Little Falls.

For the commercial lighting and power work, the Dolgeville Company has adopted the Shallenberger wattmeter. This meter is shown uncovered in Fig. 15. It measures energy in kilowatt hours, and is inclosed in a substantial metallic case, which prevents injury and tampering. On account of the fact that the torque of such a meter is directly proportional to the power passing, one of these meters will start on less than one-half of 1 per cent of its rated load, and no amount of induction can affect the accuracy of the readings. No constants are used in calculating the energy registered, inasmuch as it reads direct.

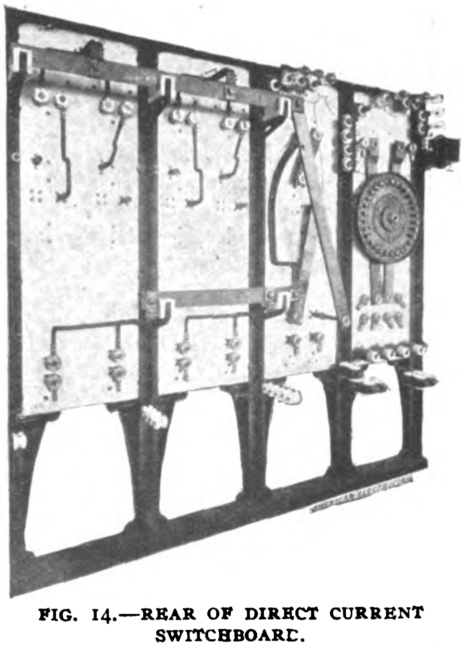


FIG. 14.—REAR OF DIRECT CURRENT SWITCHBOARD.

At present the plant is furnishing current for about 2000 lights and 350 h.p. in motors, and is reported to be working in excellent fashion.

The Transmission Line.—This will be 8 miles in length, extending from the power house to Little Falls, N. Y. The poles are 25-ft. cedars, with 7-in. top, furnished by the Kerby Dennis Company, of Marinette, Wis. They have already been set, numbering fifty to the mile. There will be one cross-arm per pole of yellow pine, 8 ft. x 4¼ ins. x 3¼ ins., well braced. No. 4 hard-drawn copper bare wire will be strung upon porcelain insulators and pins furnished by Mr. Fred M. Locke. This insulator and pin are shown in Fig. 16. The insulator is 5¼ ins. in diameter, and made from three shells of vitrified china fused together with glaze, thus affording a solid insulator of the strongest kind, both electrically and mechanically. The pin is ½-in. steel with a locust top boiled in paraffine, and a porcelain base. By the use of these an arc or static discharge will not burn them off. The sleet and moisture repelling character of insulator and pin when carrying current is therefore carried down to the cross arm; and it is estimated that the arcing distance is increased thereby, corresponding to an increase of 10,000 volts in potential.

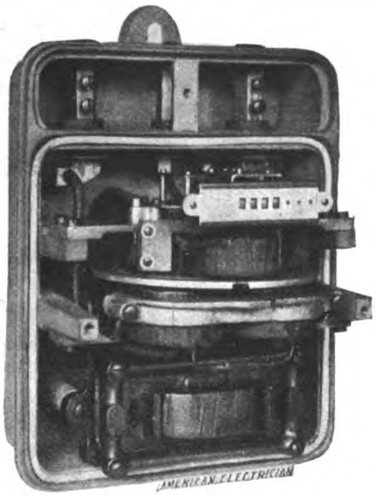


FIG. 15.—SHALLENBERGER WATT METER.

The line will carry 600 h.p. at present, at a potential of 10,000 volts, secured by means of two Westinghouse self-cooling oil type converters, which receive current at 2400 volts, two-phase, and transform to 10,000 volts, three-phase, this method being known as the Scott method of transmission. At Little Falls will be installed two Westinghouse lowering converters, which will receive the current at 9500 volts, three-phase, and transform to 2200, two-phase, ready for distribution for power purposes. The converters mentioned have an efficiency of 98½ per cent.

The transmission line will be transposed three times between the power house and Little Falls, so that each leg of the three-wire circuit will be on the same side of the line for one-third of the distance. No telephone line will be strung on the poles of the transmission line, as one already exists on a separate line running on the opposite side of the railroad. It should also be noted that the high tension line follows the tracks of the Little Falls & Dolgeville Railroad almost the entire distance.

For lightning protection the high tension circuit will be provided with Wurts lightning arresters; three being placed at each end of the line, one for each leg of the circuit. These are of an improved pattern, as manufactured by the Westinghouse Company for transmission work at high potentials. They are each mounted in a rack resting upon glass insulators and provided with choke coils. The loss in the line at full load will be 5 per cent.

In General.—The hydraulic part of the plant was designed by Mr. A. C. Rice, superintendent and chief engineer of the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. The electrical part of of the work was laid out by the writer.

The Dolgeville Electric Light & Power Company have absolute control of the High Falls water power, and nominal control of rights which will enable it to develop and market 17,000 additional h.p. The facilities for storage are of the best. The headwaters of the Auskerada form a perfect network of lakes, whose area will aggregate 10,000 acres, which is ample for the complete utilization of 20,000 h.p. The natural drainage of the stream through a thickly wooded country above Dolgeville is 260 square miles.

Within the limits of 2½ miles above Dolgeville, and 2½ miles below, the stream has a fall of 412 feet, which is divided up into eight different power sites. A plant immediately below the present installation will obtain 84 ft. of head, and next below 65 ft. The situations are ideal for cheap developments.

The Little Falls market for power is a good one, and there are others not very far away, to which will be sent in the near future power from the Auskerada. Already Little Falls has observed the value of electric power, and subscribed for 300 h.p., which will soon be ready for use.

The officers of the Dolgeville Company are, E. R. Wanckel, president; N. A. Snell, secretary; W. S. Armstrong, treasurer; Alfred Dolge, W. S. Armstrong, N. A. Snell, executive committee.

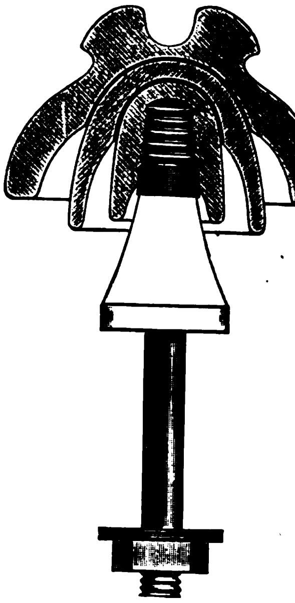


FIG. 16.—HIGH VOLTAGE INSULATOR.

ELECTRIC FAN MOTORS—1898 MODELS.

COINCIDENT with the opening of the commercial fan motor season—which precedes, by several months, the season of use—we print this month illustrations, together with brief descriptions, of the 1898 models of the principal manufacturers of this indispensable modern convenience.

The improvements made since last year present no innovations of a startling nature, but relate principally to perfection in details, increase in efficiency and better appearance. In this last particular the improvement in some cases is quite marked, both with respect to finish and shape.

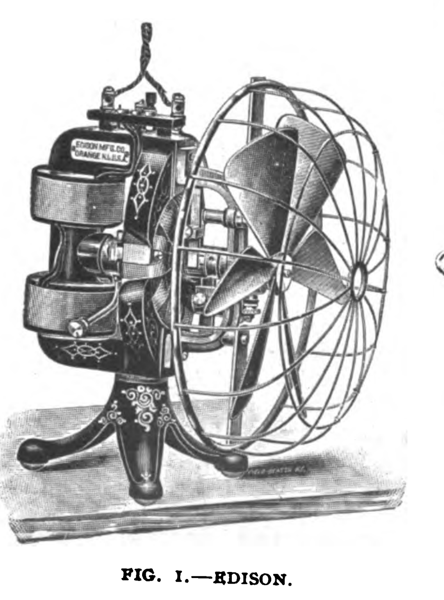


FIG. 1.—EDISON.

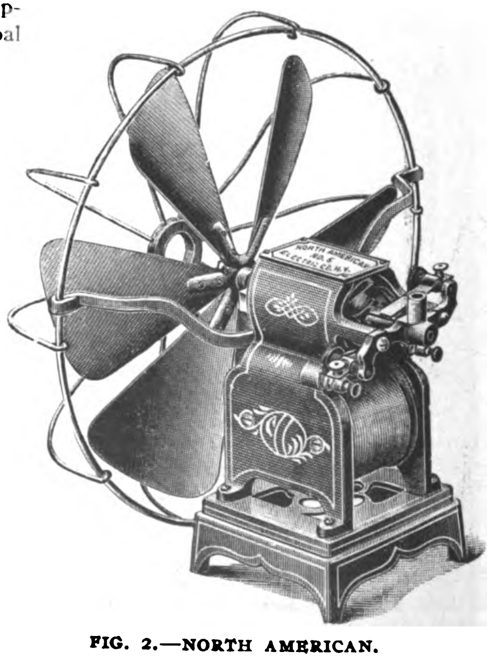


FIG. 2.—NORTH AMERICAN.

There has undoubtedly been a considerable advance in efficiency, particularly in alternating current motors. Now that the ammeter is apt to be applied to test claims as to current consumption, it is a wise business policy to strive after the highest efficiency, even at a sacrifice that might not be thought to be warranted in the absence of competition. We believe that most fan motors of the present day have efficiencies that compare very favorably with those of large power motors, taking into consideration the dependence of efficiency on size. and this is true not only of electrical but also of mechanical efficiency. In the latter respect there has been an advance through the introduction of ball bearings and niceties of fitting borrowed from the bicycle industry. Attention has also been given to the proper proportioning of the size and pitch of fans to the power of the motor—a point that formerly received little attention. It is interesting to note that in fan-work there has been a complete solution to the single-phase induction motor problem, several motors of this type being described in the following columns.

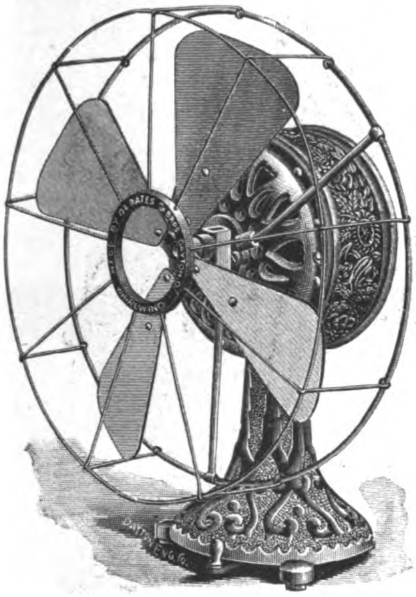


FIG. 3.—BATES—D. C.

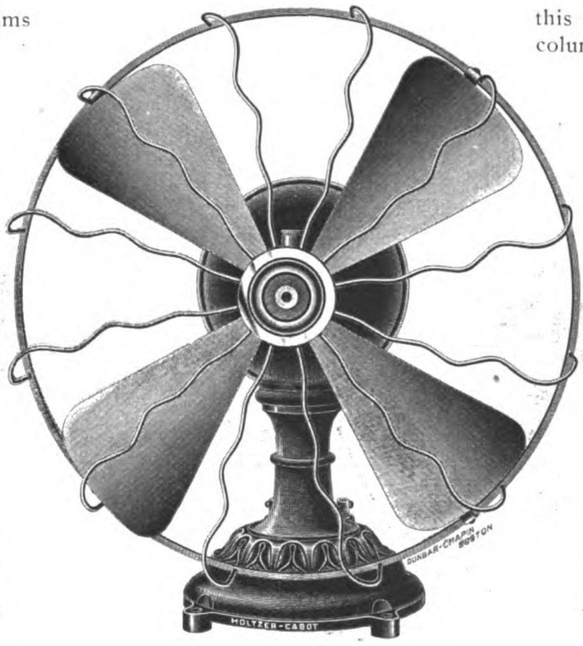


FIG. 4.—HOLTZER CABOT—D. C.

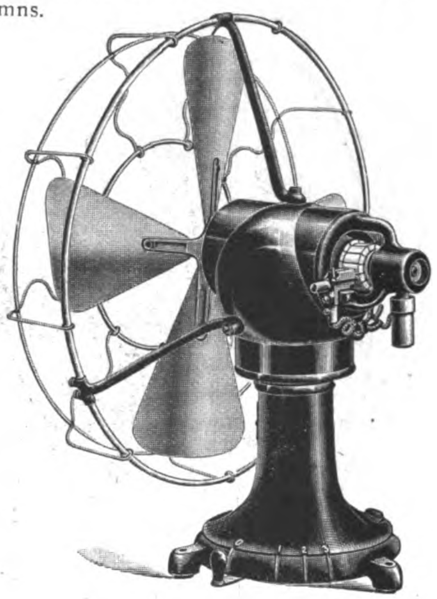


FIG. 5 —HURRICANE—D. C.

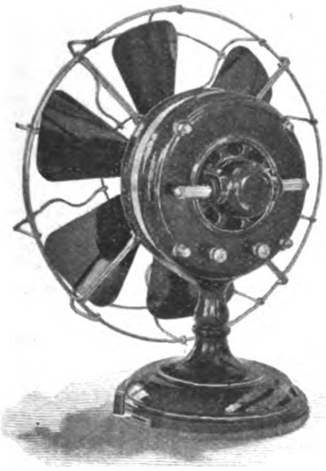


FIG. 6.—GENERAL ELECTRIC—D. C.

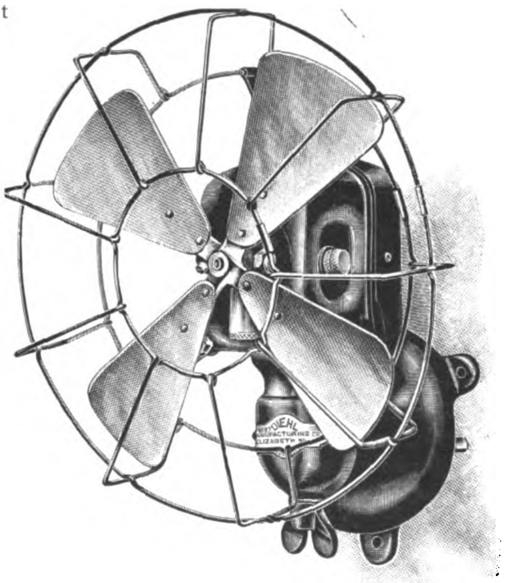


FIG. 7.—DIEHL—D. C.

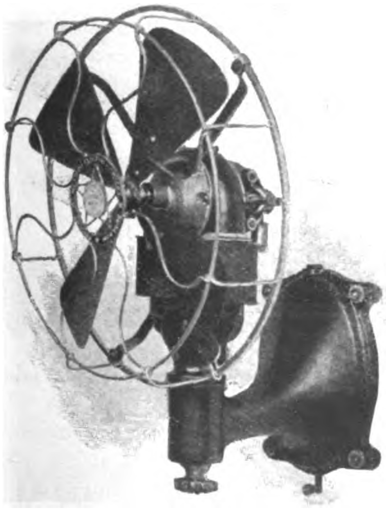


FIG. 9.—WESTERN ELECTRIC—D. C.

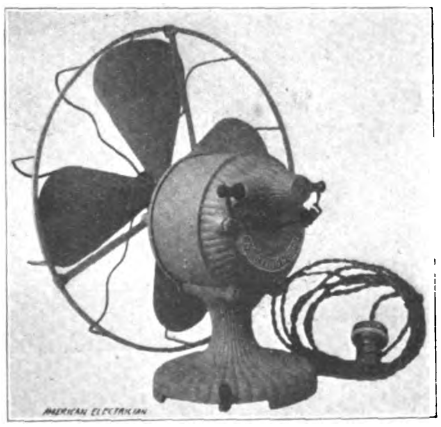


FIG. 10.—WESTINGHOUSE—D. C.

Fig. 1 shows a 9-in. battery fan running at 850 r.p.m. and taking 1.75 amps. when operated with four Edison-Lelande cells. When this type of motor was first placed on the market, some four or five years ago, the same cells ran the fan for 100 hours before needing renewal. By last year the design had been so materially improved that the

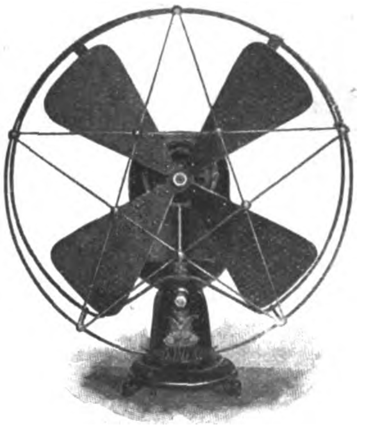


FIG. 8.—ROTH—D. C.

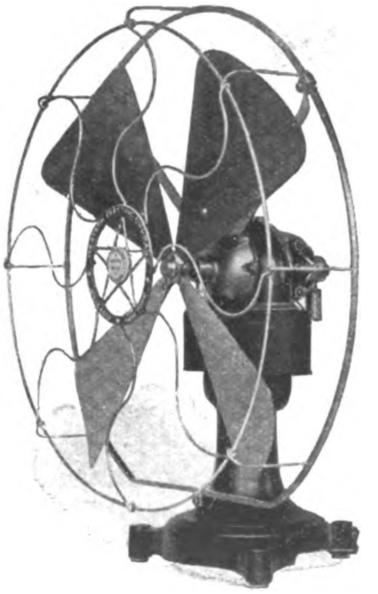


FIG. 11.—WESTERN ELECTRIC—D. C.

same battery would run the fan for 125 hours, the speed being increased to 800 r.p.m. In the 1898 model shown the economy by the use of ball bearings has been increased one-third over that of the 1897 model, and 70 per cent over that of the 1896 model, the speed of the fan being also increased to 850 r.p.m. This same motor is made for a 110-volt direct current with a 12-in. fan and guard, and furnished with a 3-speed switch, enabling speeds of 1000, 1200 and 1400 r.p.m. to be obtained.

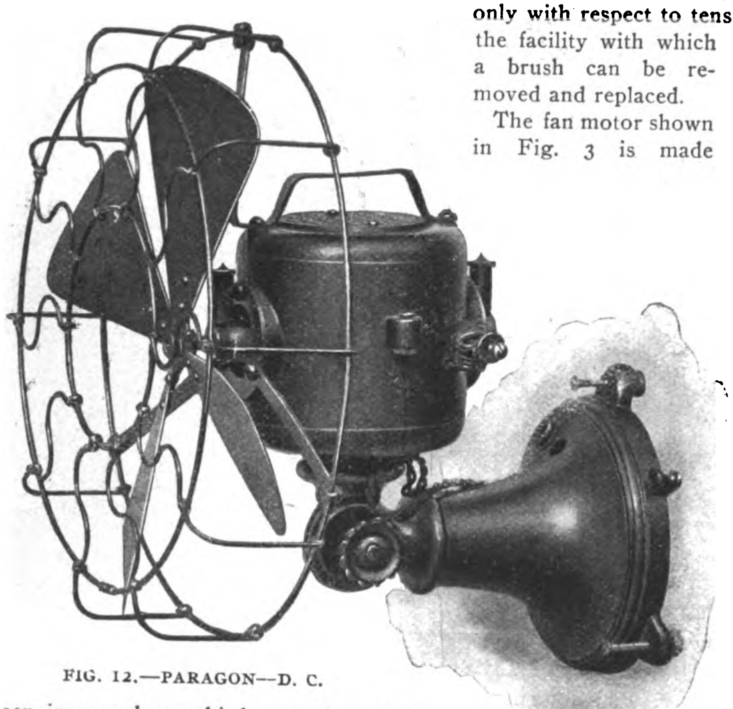


FIG. 12.—PARAGON—D. C.

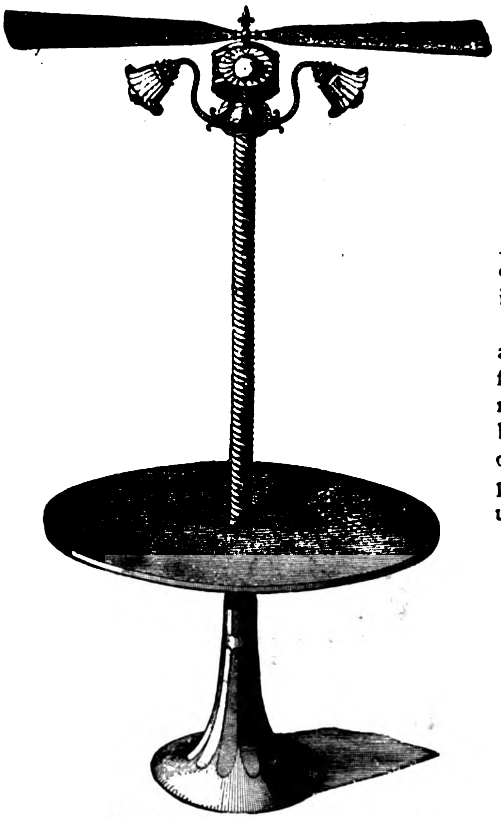


FIG. 14.—WESTERN ELECTRIC—D. C.

The motor in Fig. 2 is a 10-in. battery fan motor designed for four 2-volt cells. Simple brush adjustment is one of the claims made for this type of motor, not only with respect to tension, but also from the facility with which a brush can be removed and replaced.

The fan motor shown in Fig. 3 is made for 110 and 220-volt circuits and is also wound for 250 volts to run two in series on a 500-volt circuit. The consumption of current is .5 amp. on a 110-volt circuit for a 12-in. fan, or about equal to the current taken by a 16-c.p. lamp. There are three speeds, 1100, 1400 and 1800 per minute, except in the case of the series fans, which have but one speed. Instead of being japanned, the metal parts are given an oxidized-copper finish, and all bright work is polished and lacquered.

The fan shown in Fig. 4 has 16-in. blades and is made for 110 volts only. Both the fields and armatures are laminated, and the motor is fitted with self-feeding carbon brushes. The motor may be run at any one of four speeds, the switch being completely inclosed in the base. Oil is not used as a lubricant, the motor being provided with grease cups which require but one filling during the entire season. The shaft is made of crucible steel and the bearings of phosphor bronze, both highly polished and fitted to gage.

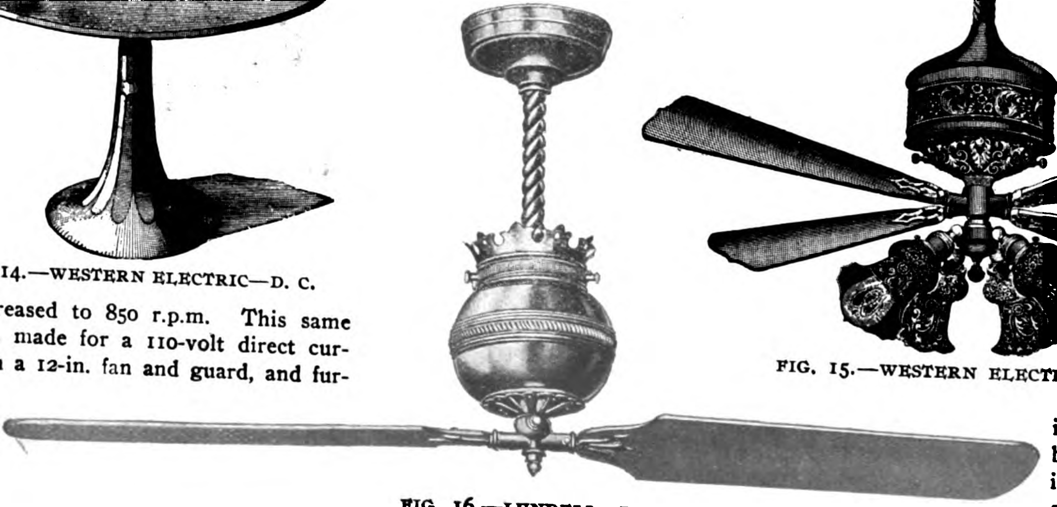


FIG. 16.—LUNDELL—D. C.

The motor shown in Fig. 5 is of the consequent pole type, and the armature is entirely inclosed except at the commutator end. By unscrewing the front bearing, the armature and commutator are easily removed. The bearings are provided with an automatic oiling arrangement which entirely prevents spraying of oil. The brushes are of flat carbon, and make end contact at a slightly obtuse angle to the commutator.

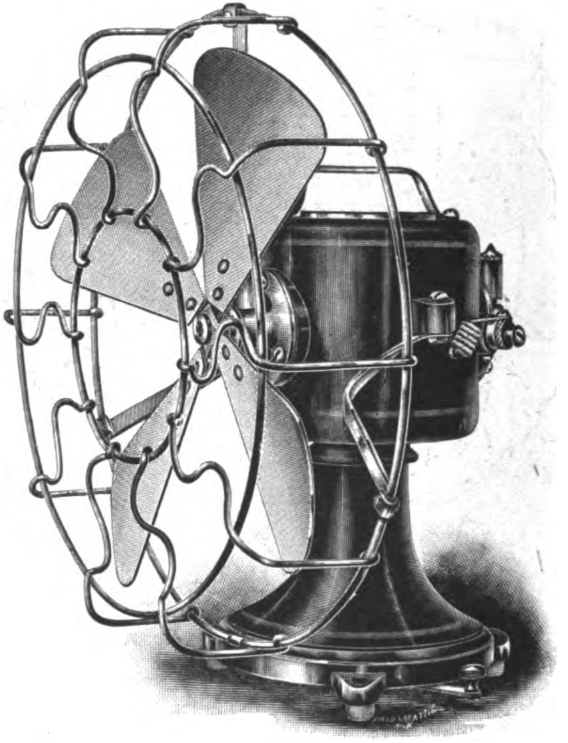


FIG. 13.—PARAGON—D. C.

The constant-current type of fan motor of Fig. 6 has but a single long bearing similar to that of the alternating current fan of the same manufacturer. The commutator is completely inclosed, and the carbon brushes are incased in small tubes which are readily unscrewed for inspection. A regulating switch provides for variations in speed. This motor is also mounted on a swivel frame which enables the

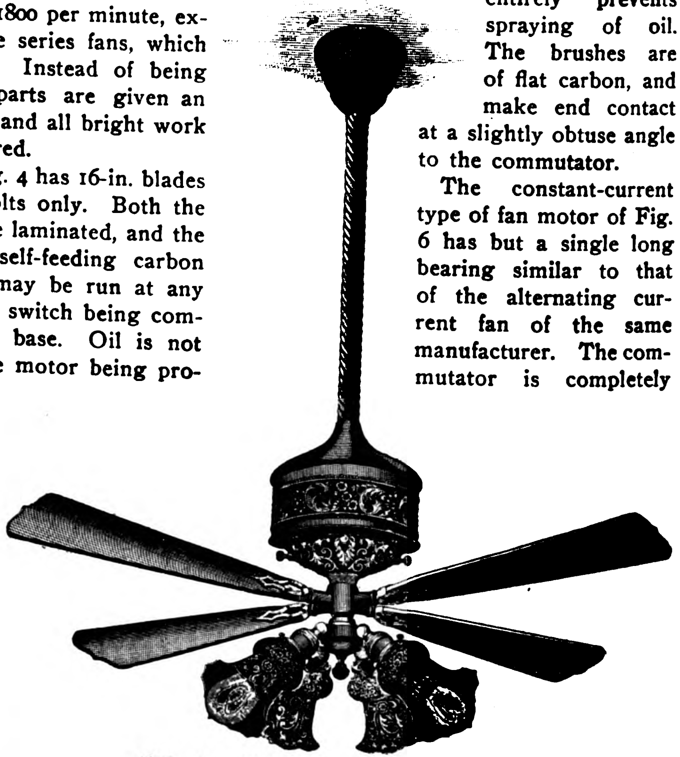


FIG. 15.—WESTERN ELECTRIC—D. C.

LIBRARY

fan to be tilted at any convenient angle.

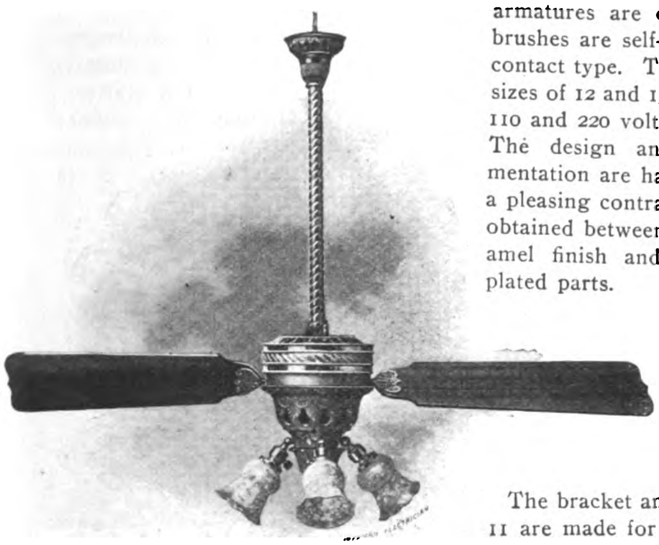
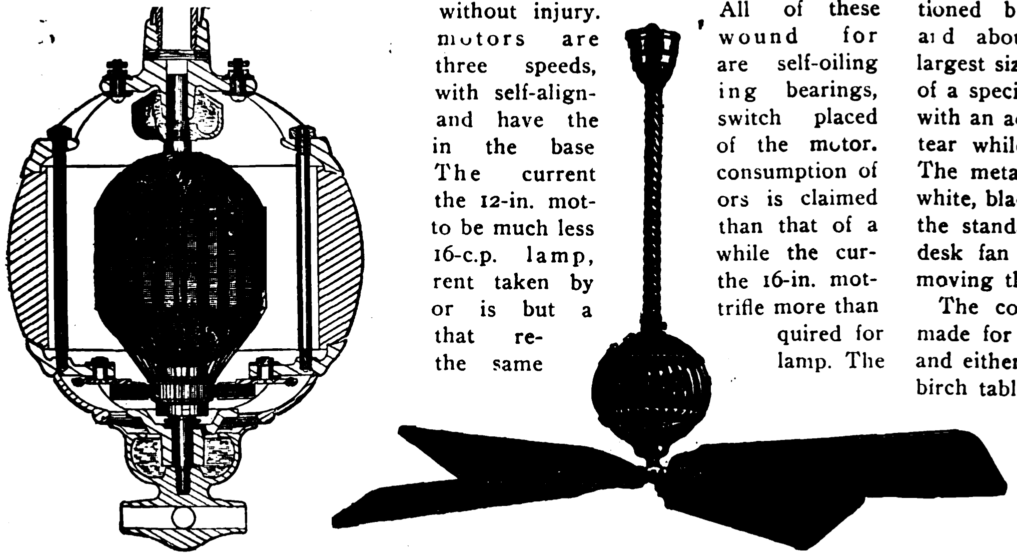


FIG. 17.—HUNTER—D. C.



FIGS. 19 AND 20.—ROBBINS & MYERS—D. C.

The type of motor shown mounted as a bracket fan motor in Fig. 7 is made in two sizes—1-12 h.p. with 12-in. blades running normally at 1850 r.p.m.; and 1-6 h.p. with 16-in. blades running normally at 1500 r.p.m. By means of a switch two other speeds may be obtained. This bracket type of fan may be adjusted and clamped at any desired angle to the side wall, the adjustment being effected by means of the wing nut shown, at the bottom.

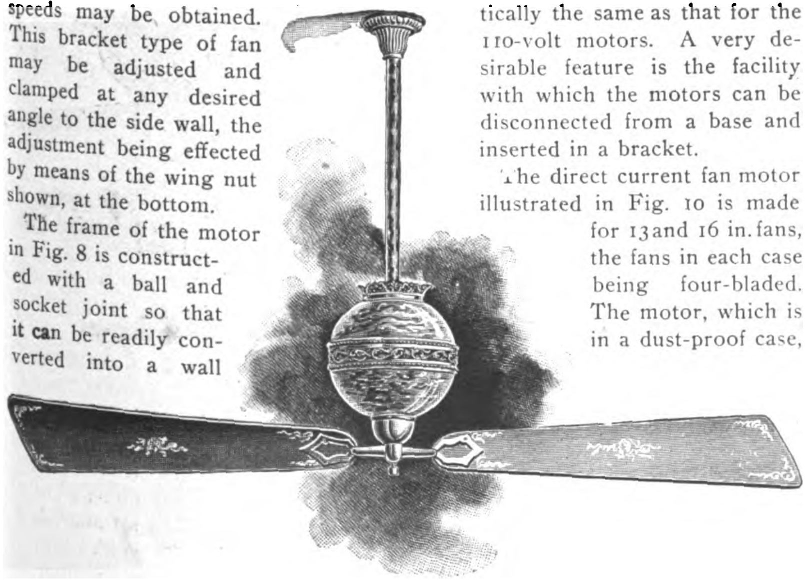


FIG. 21.—BACKUS—D. C.

The frame of the motor in Fig. 8 is constructed with a ball and socket joint so that it can be readily converted into a wall or bracket fan, as desired. Each motor is provided with a porcelain switchboard placed in the base, with a suitable regulating rheostat by means of which three different speeds can be obtained. The armatures are of the ring type, and the brushes are self-feeding and of the end-on contact type. The fans, which are made in sizes of 12 and 15 ins., are wound to run on 110 and 220 volt circuits. The design and ornamentation are handsome, a pleasing contrast being obtained between the enamel finish and nickel-plated parts.

The bracket and desk fans of Figs. 9 and 11 are made for 110, 220 and 500-volt circuits. On 500-volt circuits three 110 or two 220-volt motors may be operated in series, and the 500-volt motor can be operated on a 600-volt circuit continuously without injury. All of these motors are wound for three speeds, are self-oiling with self-aligning bearings, and have the switch placed in the base of the motor. The current consumption of the 12-in. motors is claimed to be much less than that of a 16-c.p. lamp, while the current taken by the 16-in. motor is but a trifle more than that required for the same lamp. The energy required for the 220 and 550 volt motors is practically the same as that for the 110-volt motors. A very desirable feature is the facility with which the motors can be disconnected from a base and inserted in a bracket.

The direct current fan motor illustrated in Fig. 10 is made for 13 and 16 in. fans, the fans in each case being four-bladed. The motor, which is in a dust-proof case, has laminated iron field magnets with two field coils. By throwing the fields in series, a slow speed is given; throwing them in multiple gives a high speed and cutting out one field gives an intermediate speed.

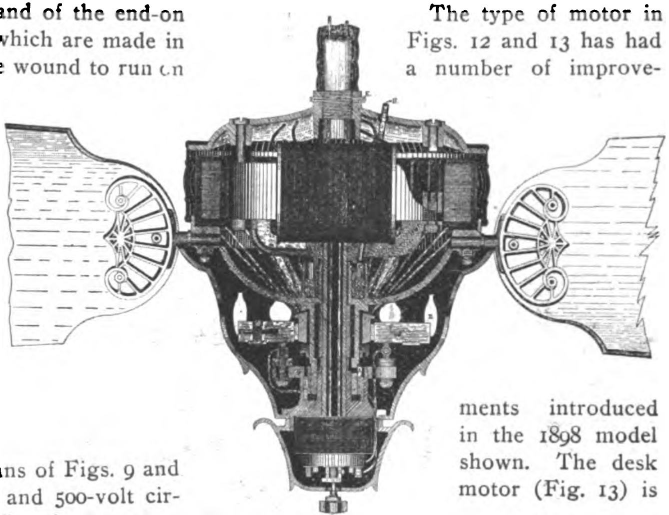


FIG. 18.—DETAILS OF HUNTER MOTOR.

The type of motor in Figs. 12 and 13 has had a number of improvements introduced in the 1898 model shown. The desk motor (Fig. 13) is made for 12, 14 and 16 in. fans, the consumption of current of the first mentioned being that of a 16-c.p. lamp, and about 50 per cent more for the largest size named. The brush holders are of a special design, using flat brushes and with an adjustment to follow the wear and tear while keeping the tension constant. The metal surfaces are finished in green, white, black, blue and maroon, green being the standard. The handle shown on the desk fan is a convenient attachment for moving the motor from place to place.

The column fan shown in Fig. 14 is made for two speeds, 150 and 175 r.p.m., and either with or without a polished, red birch table about the column. The motors are furnished with a switch, and the lights controlled by a switch placed on the under side of the table.

The ceiling fan of Fig. 15 is so made that the chandelier attachments can be readily put on as shown, every motor being wired ready for the sockets with lead wires

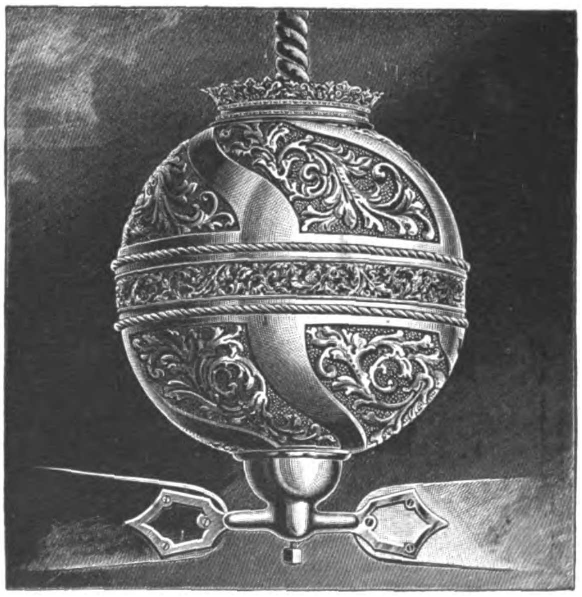


FIG. 22.—BACKUS MOTOR CASE.

coiled in the top of the switch box when not in use. With four blades 6 ins. in diameter and 8¾ ins. wide, the fan runs at 175 and 185 r.p.m. If fitted with two blades, the speed is 210 and 215 r.p.m. These fans take but a trifle more current than that required for a 16-c.p. lamp. The motors are furnished with self-oiling and self-aligning bearings and are perfectly balanced. The switch for change of speed is placed in a neat switch box on the under side of the motor case.

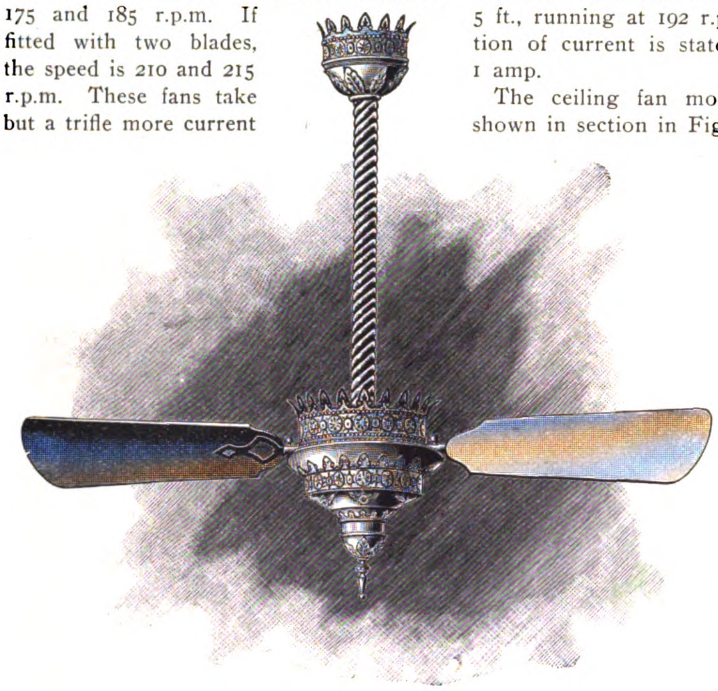


FIG. 23.—DIEHL—D. C.

The ceiling fan shown in Fig. 16 is made for circuits having voltages of 115, 165, 220, 250 and 500. The sweep of the blades is 56 ins. and their width 9 ins. The motor, which is of 1-6 h.p., is the well-known ironclad Lundell type, with cylindrical self-feeding carbon brushes and self-oiling and self-aligning bearings. On a 115-volt circuit the consumption of current is given as 1.1 amps., and ¼ amp. on 500-volt circuits.

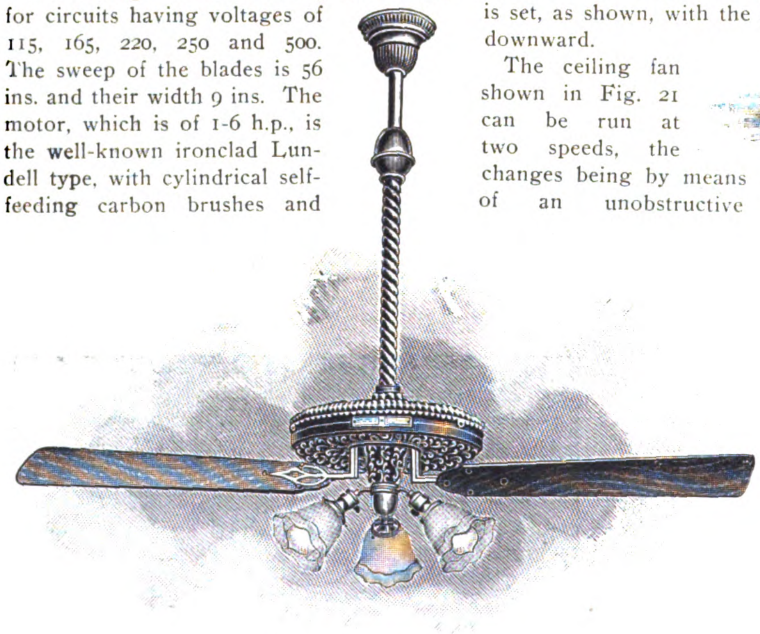


FIG. 25.—EMERSON—A. C.

The ceiling fan illustrated in Fig. 17, and shown in detail in Fig. 18, is for direct current circuits, and can be given two speeds by means of the switch shown. The armature is of the toothed type and the fields are of soft steel. The two bearings are widely separated, thus insuring smooth running, and enabling the air gap to be reduced to a minimum by obviating any chance of the armature striking the pole pieces should the bearing become worn. The bearings run in a bath of oil, which does not require renewal during a season's service. With the blades, whose sweep is 5 ft., running at 192 r.p.m., the consumption of current is stated to be less than 1 amp.

The ceiling fan motor of Fig. 20 is shown in section in Fig. 19, from which a clear idea of the construction can be obtained. The yoke of the motor consists of an iron rim to which two pole pieces are attached at diametrically opposite points. The entire weight of the armature and fan plates is borne by ball bearings which run in oil. Carbon brushes are used and the armature is set, as shown, with the commutator end downward.

The ceiling fan shown in Fig. 21 can be run at two speeds, the changes being by means of an unobstructive switch at the bottom of the fixture. The finish of the brass motor case is in mother of pearl or light onyx body, with a gilt border or crown, a nickel stem and plate holder. Fig. 22 shows another type of motor case made by the same manufacturer, which is finished in oxidized brass or silver, full nickel, or old ivory and gilt.

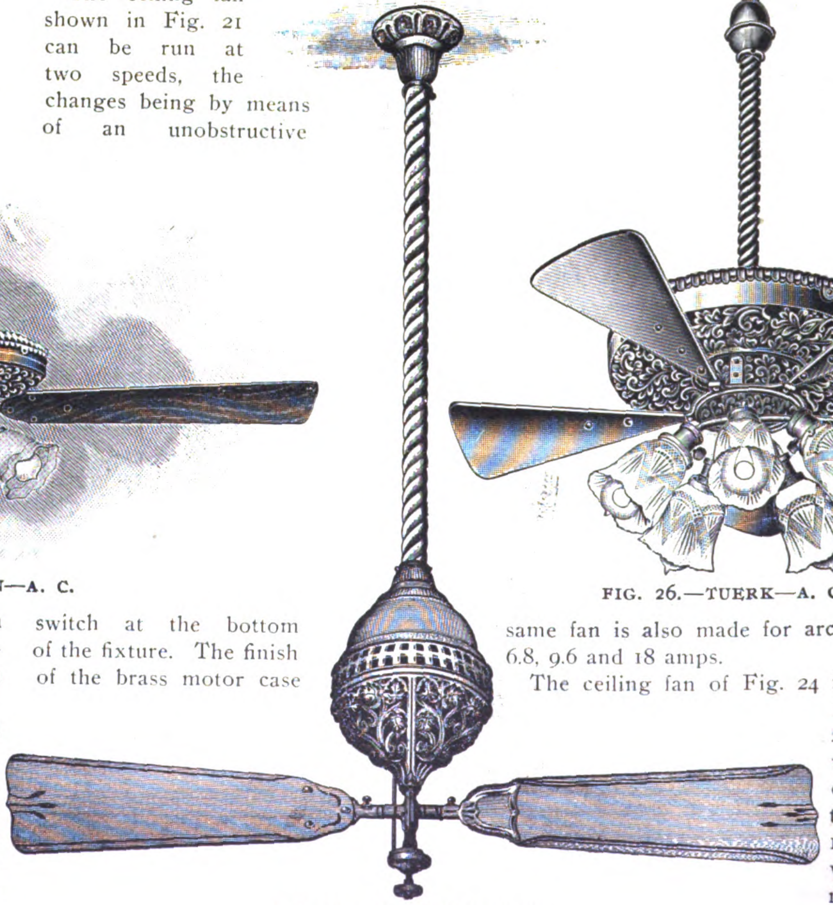


FIG. 27.—EMERSON—A. C.

The motor of the ceiling fan illustrated in Fig 23 is wound for direct-current lighting, power and street railway circuits, in the latter case being operated singly or in series of two, three or four fans. The same fan is also made for arc circuits of 6.8, 9.6 and 18 amps.

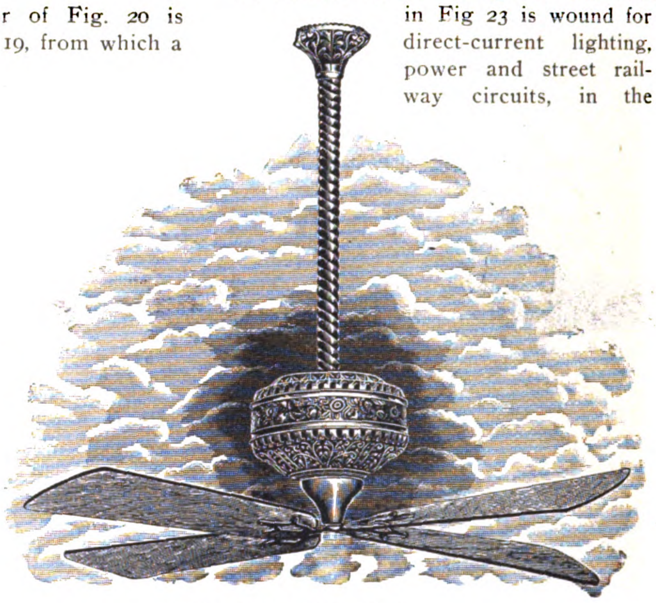


FIG. 24.—BATES—D. C.

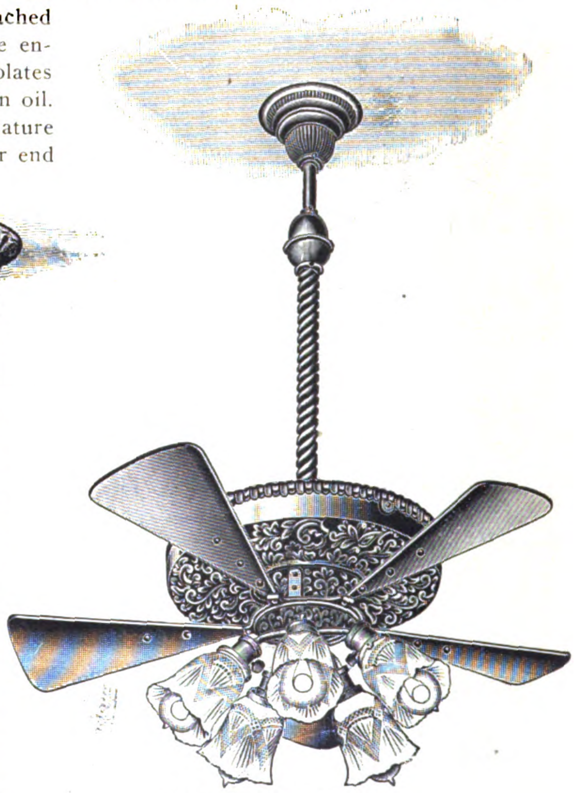


FIG. 26.—TUERK—A. C.

The ceiling fan of Fig. 24 is made for 110, 167, 220, 250 and 500 volts, direct current, those of 167 and 250 volts running three and two in series respectively on a 500-volt circuit. A similar type of fan is made by the same manufacturers for alternating current circuits.

ALTERNATING CURRENT FAN MOTORS.

The ceiling fan motor shown in Fig.25 is a slow speed induction motor for 60-cycle systems. The current consumption of this machine running at the highest speed (210 r.p.m.) is 125 watts. A second speed is also provided of 150 r.p.m., the current consumption at which is 100 watts. The same fan is also made with a current consumption of 150 watts at higher speed. The ceiling fan shown in Fig. 26 is adapted for the higher frequencies of 125 to 133 cycles per second. As an indication of the advance in fan motor design, the manufacturers state that the above fans are from 1-3 to 40 per cent more efficient with respect to the amount of air set in motion than the ones manufactured by them last year. The only wearing part in the above fans is a simple ball bearing running in oil, the fan thereby being also made noiseless.

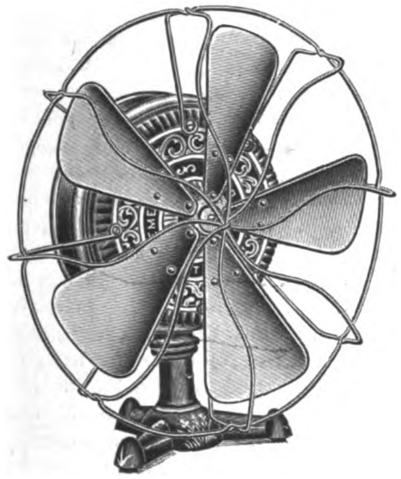


FIG. 28.—GENERAL ELECTRIC—A. C.

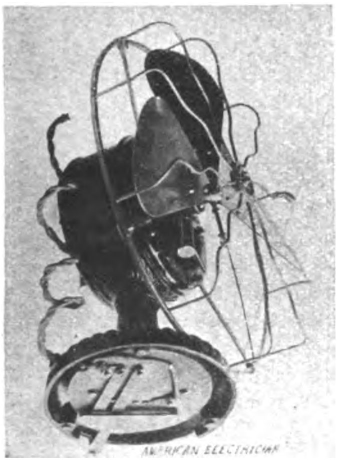


FIG. 32.—WESTINGHOUSE—A. C.

The alternating current ceiling fan motor of Fig. 27 is furnished for 60, 125 or 140 cycles, and for 52 or 104 volts. By an ingenious device the angle of the blades can be so shifted that the air may be blown downward toward the floor or upward toward the ceiling. In this type of ceiling fan reduction in speed is obtained by the introduction of leather-faced friction wheels, which enable the motors to be rotated at a slower speed than that of the armature, thus permitting the use of the highest speed and highest efficiency type of alternating current motor.

Fig. 28 shows an induction alternating current motor, the armature being illustrated in Fig. 31. The cast-iron frame supports a single long bearing, and to the frame are bolted soft iron laminations which make up the field core, being provided with inwardly projecting teeth to form the poles on which are placed the field coils. The armature is also built up of soft iron laminations assembled on a brass spider, but has no insulated wire; bare copper rods run through the core and are riveted into the discs at each side, as shown. Rotation being produced by inductive action, no commutator or brushes are required. This motor is built for 52 and 104 volts and 60 and 125 cycles, and by means of an inductive resistance can be run at any one of three speeds by operating a switch.

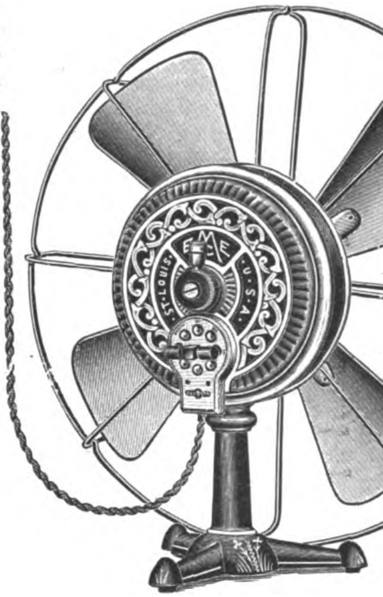


FIG. 29.—EMERSON—A. C.

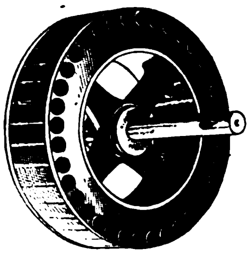


FIG. 31.—ARMATURE OF GENERAL ELECTRIC A. C. FAN MOTOR.

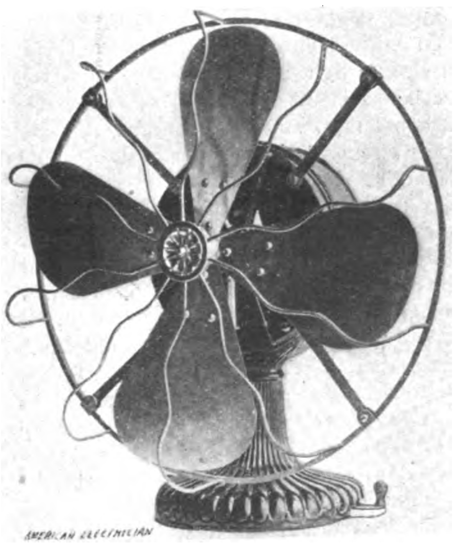


FIG. 33.—WESTINGHOUSE—A. C.

The desk fan illustrated in Figs. 29 and 30 are for alternating currents. The shaft of these fan motors is pressed firmly into the back cover, and is made of ½-in. bicycle tubing, case hardened and ground accurately to size. The armature hub is composed of a larger piece of bicycle tubing, into which is pressed at either end a bushing, reamed to accurately fit the hardened steel shaft. Another improvement is in the switch plate, which is made of porcelain, the binding posts being concealed so as to make it impossible to receive a shock in handling the motor. The 12-in. motor (Fig. 30) consumes from 65 to 70 watts in starting, running at about 1550 r.p.m.; in one position of the switch, this consumption is cut down to 50 watts, while in another it is cut down to about 35 watts, the speed being 950 revolutions in the latter case. The current consumption of the 15-in. motor (Fig 29), is 110 watts on the starting point at about 1550 r.p.m.; in the second position of the switch the consumption is reduced to 90 watts and the revolutions to 1500.

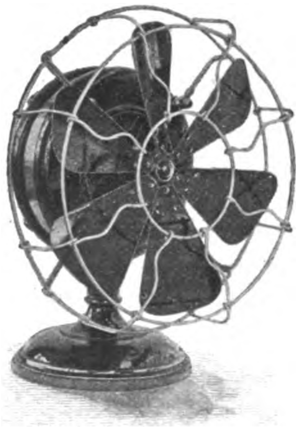


FIG. 30.—EMERSON—A. C.

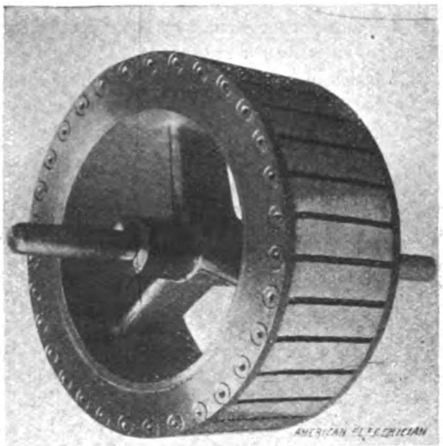


FIG. 34.—ARMATURE OF WESTINGHOUSE A. C. FAN MOTOR.

The alternating current fan motor illustrated in Figs. 32 and 33 is of the induction type, having no collector rings or brushes.

The field is built of thin, soft steel plates, with inwardly projecting teeth to which the field winding is applied. The armature is laminated, being built of steel discs slotted to receive the bar-copper conductors, as shown in Fig. 34. No insulation is used in the armature, and consequently there is nothing to burn out. By means of a three-contact switch located in the base, the motor may be run at full speed, at a moderate speed or it may be cut out of circuit. This type of fan motor is made for frequencies of 60 and 133 and for 50 and 100 volt service. The bearings are self-oiling and self-aligning, thus reducing friction to a minimum.

GETTING EXPERIENCE.

BY * * *

Before the technical schools began to turn out their annual crops of electrical engineers, and, indeed, before there were any technical schools teaching electrical engineering, I determined to learn the subject as thoroughly as I could and to devote myself to its practice. This was in those remote days when the electric railway was the subject of more or less promising experiments, when the electric light was still a sort of curiosity, and a most expensive one, and when the electric motor was regarded an experimental novelty.

How and where to be instructed in the mysteries of electricity was, in those days, a problem of no small order. There were few schools that offered even an apology for a course in electricity, and such as there were confined themselves to the purely scientific side of the subject. There was not a solitary technical course in existence, not a place where a student could learn the practical side of electrical work. The only thing to do was to supplement the lectures and physical laboratory work of the school with a term of service in a shop. In an evil moment I decided on this course.

It was after two years of instruction in the mathematical theory of electricity that I presented myself to the superintendent of one of the few factories then engaged in building dynamos and motors, and asked him to let me work in his shop without pay. He was a courageous man, and consented, but I have always thought that if he had known how amazing green I was he never would have taken the chances that he did.

At that period I knew Gauss' theorem, but I could not have soldered a joint had my life depended upon it. I could talk glibly about ether stress, but a station switchboard appeared to me as a dark and fearful mystery. In this frame of mind I reported for work Monday morning.

My first duties were to take castings off the dray that delivered them at the shop door, groom them with a chunk of emery and send the smaller ones aloft on the elevator. In a few days I was intrusted with a chipping chisel and shown how to cut off various excrescences that would not yield to the emery stone. The next job that fell to my hands was operating a punch press, cutting armature discs. I had an old 12-in. screw driver, with which I was instructed to pry recalcitrant discs out of the die, and during my first hour at the machine I managed to cut it into three neat pieces, to the everlasting ruination of the die.

By slow steps I was promoted to the winding room, where a pervasive atmosphere of shellac and rosin enwrapped everything, until a new insulating material was brought in that smelled worse than all the other scents of the shop combined. Here I learned the technic of the soldering iron, complex methods for clothing an armature core in its winding and many other useful and interesting things. The fine art of armature winding is disappearing in these days of slotted cores and machine-made coils. Then we had smooth cores and all the winding was hand work. To make a neat end on a surface-wound Siemens armature is a really difficult piece of work, and one calling for no little skill and experience. To balance such an armature calls for heaven-sent genius.

When I had worked my way through the various departments of this shop, I concluded to try to learn, in the same way, something about electric lighting. I commenced my labors in a station in a Western city by shoveling coal from the railway cars into a chute. This is excellent exercise, and as it affords an unlimited opportunity for meditation and reflection, very beneficial experience. There were times before I finished with that station when I would have given a good deal to get back my old job of coal shoveling. As stoker, oiler, dynamo attendant, switchboard man and, in the absence of the superintendent, general *charge d'affaires* about the station I absorbed very much that I could have learned in no other way; but I think my most illuminating experience was gained in a brief season of work outside, as lineman, trimmer and wireman. During this time I contracted the pliers habit, a vice to which young electricians are prone. At first, proud of the pair of pliers, which is the outward and visible sign of their calling, they soon find themselves so dependent upon this instrument, and so apt to put it to all sorts of uses, that they can hardly dress in the morning without it.

Of all the laborious work connected with an electric light station I believe trimming arc lamps is the hardest. We had single carbon lamps, and those on the all-night street circuits had to be re-trimmed about midnight. It is not only hard labor but very dangerous labor to go up on an icy pole on a stormy night, and blinded by the blazing arc, turn the switch, throw out the hot points, reach around behind for a new pair, put them in and straighten them in the dark, and then throw the switch and climb down again. It doesn't sound hard, but the total height to which a trimmer climbs in a day's (or night's) work is generally over 1000 feet, and this is vertically upward, with a heavy bag of carbons and tools as impediments. Add to this the dangers of shocks and falls, and it will be seen that the trimmer earns his pay.

We had a few motors, all of them series machines, working on the daylight arc circuit. This was a fairly heavy circuit, the voltage running up to over 4000. To treat an ailing motor with this voltage "lying 'round loose," and a probable ground somewhere, required nerve, if the man who did the job understood the conditions. Generally he did not, and was none the worse for his ignorance, though I remember some narrow escapes. We had a motor in a second story printing office, back of which was a tin-roofed shed. The wires to the motor were about eight feet above this shed. One day when the motor was in trouble, Lanigan, the head wireman, was sent to its rescue. His first move was to put a "jumper" across the two wires outside the building, and to do this he mounted on the roof of the shed. Happily the roof was dry, but the usual ground was on the circuit, and when Lanigan undertook to "skin" the wire for attaching the jumper the yell he let off was heard three blocks. I have never understood how he escaped death, anyhow. His invariable custom was to attach the house leads, in an incandescent wiring job, to the leads on the pole outside, and to work his way into the building with everything "alive." One day he got a shock from an arrangement of this kind that knocked him off the top of a high step-ladder into a bin of oysters that were awaiting canning. It was the custom to send oysters (opened) in bulk from the coast and can them in our town, after proper disinfection. The accident I mention damaged Lanigan somewhat, but didn't hurt the oysters.

There was one night, a windy night, with a wet snow, when somebody started up an arc circuit "upside down"—that is, with the current going through the lamps so that the short carbons were positive. In an hour or two the lower carbon holders were blazing up in a magnificent pyrotechnical display of green fire. That was the night that I resigned my position as trimmer.

The real excitement in those times, however, was a fire. This was long before the days of conduits, and pole lines carrying twenty or thirty circuits of arc wires and a few heavy incandescent feeders were quite common. The firemen were desperately afraid of these wires, and men that would face any kind of danger from fire or falling walls, balked at orders to go among them or throw streams of water near them. On occasions of this sort some of us had to go up the poles and cut the wires, and it took a steady hand and considerable trust in Providence to do it. There was not much monotony about central station work in those days.

The experience gained in this way is of a sort that is always useful to the engineer. It is rather a hard school, but there is no better. Given a foundation of instruction in scientific electricity, so that he may understand what he sees, the student who is willing to soil his hands with hard work will learn practice very rapidly. There are many young men who could have entered our station and calculated efficiencies, drops, capacities, everything—who would have been utterly helpless in the presence of a heavy short circuit and a blazing switchboard. I am convinced that I learned more in the year I served without pay, more that has been valuable and useful to me since, than in any other year of my life.

LIBRARY

ELECTRICAL DECORATIONS.

How to Produce the Effect of a Waving Flag.

BY C. R. PERSONS.

The switch here described is one that was used during the National holidays last July in the main court of the Palace Hotel of San Francisco. It operated a very handsome American flag, which was composed of over 320 miniature lamps. The flag in question was placed on the face of the third-floor balcony, and was admired by hundreds while it was in operation. The entire arrangement was the work of Mr. Edgar Gribble, chief electrician of the hotel, who very kindly furnished the writer with the data, etc., the accompanying sketches.

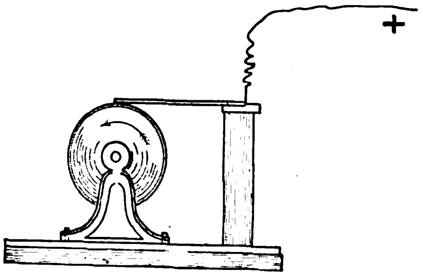


FIG. 1.—SIDE VIEW OF SWITCH.

Before describing the switch and flag, I will state that the Palace is illuminated by over 6000 16- and 32-CP lamps, in addition to which standard lamps, many hundreds of small 3- and 4-CP lamps are used in decorative candelabra in the grill rooms, parlors, etc., the latter are connected five in series.

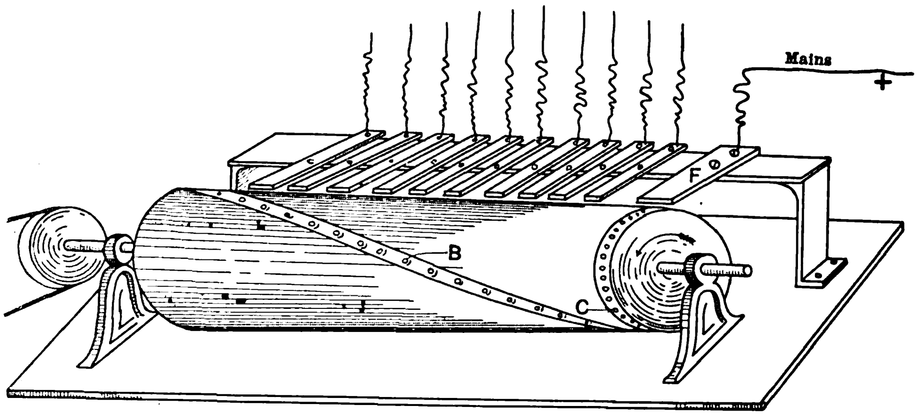
The hotel formerly had its own electric plant, but at present current at a voltage of 120 is supplied by the underground mains of the San Francisco Gas & Electric Company. The hotel management has placed a large and well equipped laboratory at the disposal of its electrical staff, and here during spare moments Mr. Gribble and his assistant arrange many of the novel effects for the benefit of the hotel patrons. During the late International Christian Endeavor Convention in July, the house was the headquarters of the United Society of C. E., and as a compliment to them, Mr. Gribble arranged a large electric monogram of the C. E. emblem. Over 600 miniature lamps were used, the C. E. being formed of yellow and the background of purple lamps. Purple and gold were the Convention colors, and the effect was extremely brilliant.

Returning to the subject of this article, the list of materials to be used in the construction of a flag-switch is as follows:

One sheet 1/16-in. copper, 20 ins. X 6 ins.; 1 strip 1/16-in. spring brass, 138 ins. X 1/4 in.; 2 bearings; 1 piece of hardwood, 14 ins. X 24 ins. (1/2-in. stock); 1 cylindrical piece of wood, 20 ins. X 6 ins.; 2 pieces of 3/4-in. steel (or iron) shafting, 6 1/2 ins. long; 2 or 3 dozen copper washers; 2 or 3 dozen brass screws, and an assortment of iron screws; 1 piece of tough asbestos cloth large enough to cover the cylinder mentioned below.

The above list will probably cost $2 or $3, and most all of the material can be usually found in the scrap heap of any electric-light or power station.

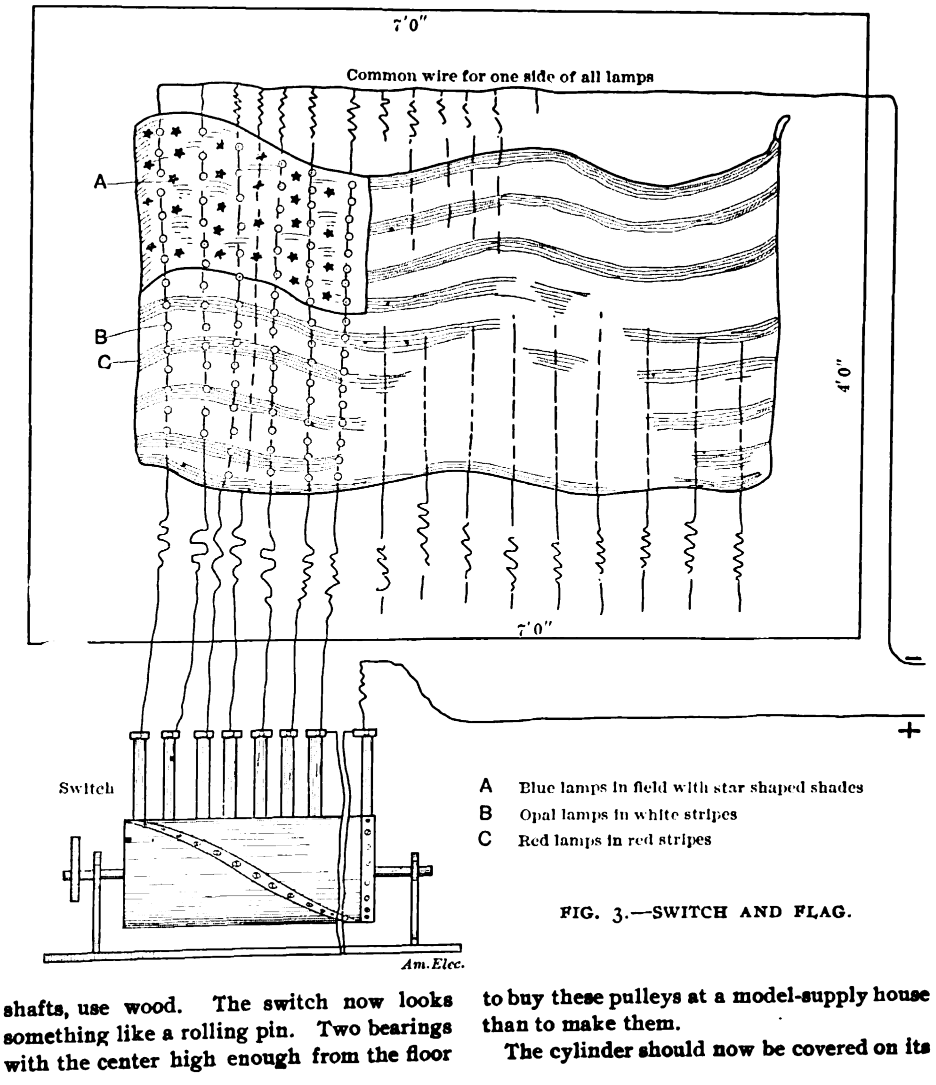
The cylinder of wood will first receive attention. It will be best to have it trued up on the lathe in the planing mill, and also have each end bored to the depth of 4 or 5 ins. so that the pieces of shafting may be driven in tight, one in each end. The writer would suggest that unless the person making the switch has had experience in wood-work, it would be better to have the turning and boring done at the mill, and this is all the machine work to be done.



B One of the 1/16 copper contact strips
C Brass or copper collar around end of cylinder
F Main copper contact brush

FIG. 2.—COMMUTATING SWITCH.

If it is not convenient to use steel for the shafts, use wood. The switch now looks something like a rolling pin. Two bearings with the center high enough from the floor to allow the cylinder to revolve freely, are mounted on the hardwood base-board. These bearings may be purchased at any model-supply house, or can be very easily made by using two pieces of hardwood and boring the upper end of each with a hole large enough to take the 3/4-in. shaft. A piece of brass tubing should be driven into each hole for the shaft to revolve in.



A Blue lamps in field with star shaped shades
B Opal lamps in white stripes
C Red lamps in red stripes

FIG. 3.—SWITCH AND FLAG.

At one end of the cylinder the shaft is allowed to protrude about 3 ins., and about 1 1/2 ins. at the other, and a pulley, either grooved or flat-face, is tightly keyed on to the 3 in.-end of the shaft. The pulley can, of course, be made of wood, but a brass or iron pulley would look neater. It will be much cheaper to buy these pulleys at a model-supply house than to make them.

The cylinder should now be covered on its face with either asbestos, or any good fireproof insulating paint. A ⅜ in. × 18 in. copper strip should be cut from the sheet of copper and be fastened spirally around one side of the cylinder (see Fig. 2). On the other side of the cylinder another copper strip should be placed, both of these strips being securely fastened by screws countersunk so that a smooth sliding contact can be easily made with the spring contacts, also shown in Fig 2.

To get the correct shape of the two contact strips, it would simplify matters to cut them out of pasteboard and when the shape has been made exactly right, to cut the copper strips from the pasteboard patterns. A frame of hardwood is also made, which should be long enough to carry all the brass spring circuit contacts, and high enough so that when the contacts are screwed on they will press firmly and evenly on the copper strips on the cylinder.

One end of the cylinder is covered with a brass or copper collecting ring with a face of 1 in., and both of the copper contacts connected electrically with this ring. A stout 1/16-in. spring copper brush with a 1-in. face is fastened to the frame, and must be arranged to press firmly on the brass ring, in the same manner that brushes press on the commutator of a dynamo.

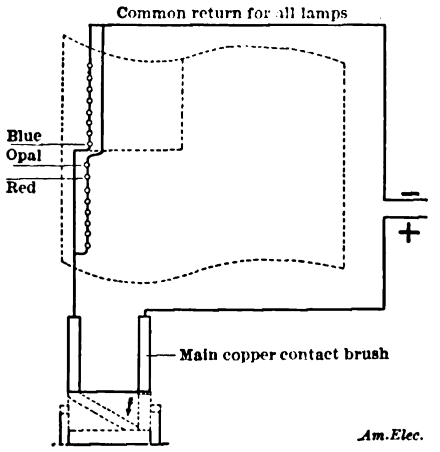


FIG. 4 —DIAGRAM OF CONNECTIONS.

The sketch, Fig. 2 shows, without further explanation, the general appearance of the switch and the arrangement of the parts. The brass contacts are made from the long strip of spring brass, and two holes for screws are drilled in one end of each, the other end being bent slightly so as to make a more binding contact on the copper. One of the screws on each strip is used with a washer to fasten the circuit wires to. The strips are each about 9 ins. long by ¼ in. broad and 1/16 in. in thickness, and are placed so that they will all strike the center of the cylinder, as shown in Fig. 1.

To prevent sparking, on the side of each of the copper contact strips nearest the rear frame, a small groove must be cut in the face of the cylinder, which groove need only be ⅛ in. deep and ½ in. wide; it should be slightly curved and must follow the strips from one end of the cylinder to the other. The grooves will cause the brass contacts, when they break the circuit, to spring in to them so suddenly that only a slight spark will follow. The cylinder must have no end play and should move easily. Oil cups may be screwed into bearings, or oil holes may be left for lubrication. The American flag is made as follows:

Procure several ½-in. white or sugar-pine planks, 12 or 14 ins. in width, and fasten them together by battens on the rear side, thus forming a surface 9 ft. × 5 ft. Of course, this depends on the size of flag desired, as the larger the surface, the more lamps will be required and the more current will be consumed. The flag in the Palace courtyard was 6 ft. long and 4 ft. broad, and 320 lamps were needed to give a proper effect.

An American flag having the appearance of waving is painted on this surface, using paint without gloss. The rest of the surface not covered by the flag is stained a dull black.

Small lamp receptacles can be very easily made, or may be purchased to fit the small lamps to be used on the flag. Connect these in series as indicated by the maker (eight is the usual number so connected). Use red lamps on the red strips, opal (not clear) for the white, and for the blue field, use blue lamps with a star-shaped white shade. Be careful to make the flag according to the latest type of "Old Glory," or every schoolboy in town will be laughing at you.

The method of connecting the flag and switch is shown in Fig. 3. All the wiring should be done on the rear of flag. Make the common return for all lamps of No. 10 B. & S. gage and of No. 14 for the circuit wires.

The operation of the switch is very pretty, and is as follows: As the spiral-shaped copper strip comes around, it makes connection in regular order with the first brass contact piece; the lamps then light up, and as the revolution continues the second circuit is lit up, each section going out as the other one lights up, and so on. Finally, the sign is rapidly illuminated until the whole flag is lit up, the large contact piece touching nearly all the circuits at once. One end of the strip shown in Fig. 2 should be broader at one end than at the other; the broad end allows the lamps last lit to stay illuminated the longest.

The shape of the copper contacts causes the flag to light up each section from the pole end, and the lights chase across the flag rapidly from left to right, producing the exact effect of a flag waving in the wind.

The writer, of course, has left many little ideas to the reader's good judgment, and very likely many other ways may be suggested in which this switch can be used. The motive power is a small electric or water motor belted to the pulley. If the motor runs too fast or slow, gear wheels of the proper pitch will give any desired speed.

In the sketches shown I have only drawn a few circuits, the total number depending on what use the switch is to be put to. The cylinder at the Palace Hotel was arranged for twenty-three circuits, and there was space left for ten extra circuits. If the reader objects to painting his flag on the board surface, there is no objection to making it of silk or satin. Whatever it is constructed of, *it must be arranged in wavy lines.*

It is not necessary to use costly rubber-insulated wire to carry current to the flag; as the circuit wires running to each section of flag are of the same polarity, any annunciator wire may be used. Bunch the wires in a neat cable, wrap the cable with tissue paper and then carefully tape it. The paper gives additional insulation, and if it is desired to use the wires again for bell work, they are not soiled.

In the Palace design each section was composed of sixteen lamps arranged eight in series across the mains, the method of connecting being shown in Fig. 4. But one of the brass spring contacts is shown, as all the other sections are similarly arranged.

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ELECTRICAL SIGN SWITCHING.

BY GEORGE T. HANCHETT.

Electric signs have now come to be a popular method of advertising, and in order to utilize them to their fullest extent it is often desirable to be able to switch them in and out in various ways. Nothing is more likely to attract the attention of the passerby to the advertising sentiment than suddenly flashing it before him in brilliant lights, and this effect can be varied in scores of ways. Such sign manipulation requires an intermittent switch system, and many such have been devised, most of them requiring a motor to drive a rotating cylinder or similar device.

A few expedients are herewith shown which, though they may be readily criticised with regard to durability and convenience, have the merit of great cheapness and adaptability. The first of these methods is a very simple one, and can be arranged to give any combination of progressive switching that can be conceived.

A rectangular pan is provided—one of agateware will answer, or one may be made of wood, and is fitted with an iron tube at its base, as shown in Fig. 1. To this tube is connected a piece of rubber tubing, two or more yards in length, the other end of which is connected to a glass reservoir, which can be conveniently made with a bottle, the bottom of which is perforated with a single hole. This hole may be conveniently drilled with a hard steel drill moistened with a solution of camphor in turpentine. Instead of using the drill, a hole may be bored with a rattail file, the end of which has been snapped off. The file is used after the manner of an awl, and is moistened with the solution before mentioned. It is hardly necessary to say that care and patience are essential.

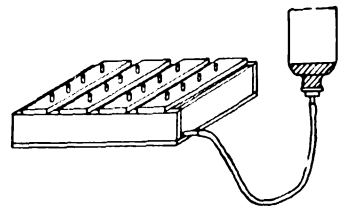


FIG. 1.—MERCURY SWITCH.

The bottle carrying its rubber tubing is connected to a frame, whereby it can be readily raised or lowered. If the machine is to be continuously driven by power, a crank and connecting rod will give the necessary reciprocating motion, and if manipulated by hand, a simple windlass will suffice.

The apparatus is filled with enough mercury to raise or lower the level of that liquid in the pan ¼ or ½ of an inch, and consequently the pan, the tubing and the reservoir should be selected of the smallest possible sizes that will give the necessary results, for the mercury is expensive.

Across the pan are secured hard rubber or fibre strips, which may be fastened with small screws at the edges, and in these strips are bored holes, 1-16 of an inch in diameter, so that they will fit a short piece of iron rod with a pointed extremity, as shown in Fig. 2. Each rod is fitted with a binding screw, such as is shown in the figure. This screw serves to secure the connecting wire. If desired, a second screw may be provided to secure the iron rod and allow its length to be varied, but it is more convenient to use non-adjustable binding posts, as described below. The sign lamps are all connected with one terminal to one of the mains, the other terminals being connected each to one of these binding posts over the mercury bath.

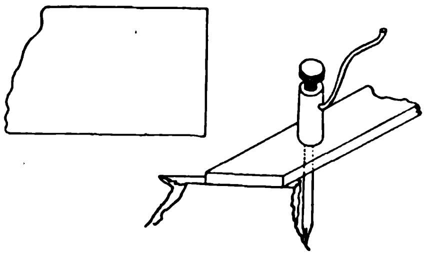


FIG. 2.—DETAILS OF MERCURY SWITCH.

It will be found convenient, though a little more work at first, to provide standard non-adjustable binding posts of different lengths, and mark them 1, 2, 3, etc., in the order in which they will meet the surface of the mercury as the latter rises. Let us suppose that we have a sign in which we wish to switch in each lamp successively, thus giving the apppearance of tracing the letters in fire. We simply connect the lamps in the order in which they are to be switched in respectively to binding posts 1, 2, 3, 4, etc., which binding posts, if the apparatus is well made, can be placed in any of the prepared holes. Raising the tank *A* will raise the surface of the mercury and make the contacts in the required order. The main terminal which feeds the mercury bath may be the pan itself, if the latter is of sheet iron, or it may be a loop of iron wire lying in the bottom of the pan. Iron should be used for all the metal contact with mercury, for the reason that it does not amalgamate with the latter.

It seems at first an expensive method to use a mercury tank and raise the level of the mercury rather than to lower the contacts into it, but it will be found that a mechanical device which could squarely and accurately lower a frame of contacts into a pool of mercury, would cost more and be more liable to be unsatisfactory. Each of these contacts should not carry more than ½ ampere.

It can be easily seen that with a suitable assortment of binding posts, any combination can be obtained. In spite of the possibilities in electric sign switching, many advertisers seem to prefer the simple expedient of alternately switching the sign off and on, and motor driven switches of various kinds are employed. A small motor, which must inevitably run at a high speed, is usually utilized, and invariably necessitates a complicated reduction in gearing, by a train of pulleys or gears.

A simple expedient which will work for 10 amps. or less is shown in Fig. 3. It consists of a supply reservoir, a tantulas cup, and a suitable receptacle for catching the intermittent overflow. The liquid is highly acidulated water, and in the tantalus cup are placed two terminals, consisting of broad lead plates, not more than ⅛ of an inch apart, and as large as possible. These two terminals are interposed in the lamp circuit. When the cup is empty the circuit is open, and while it is filling the circuit is closed, provided that the terminals are in the bottom of the cup.

If the terminals are raised to ½ the maximum depth of liquid, the period of illumination will be proportionately diminished, and thus any period can be obtained. The frequency of the cycle of events can be regulated by regulating the flow of the stopcock.

The only care that the apparatus will require is occasionally refilling the upper reservoir from the lower one. If the tanks are of suitable capacity, the apparatus will run for a given period and then stop altogether. Thus 120 cupfuls of acidulated water may be placed in the upper reservoir, and the stopcock set to flow at the rate of one cupful in two minutes. On closing his store at at 6 P. M. the proprietor may thus arrange his sign, which will operate for four hours, and when the streets begin to be deserted, at about 10 P. M., it will automatically shut itself off; and, obviously, by suitably arranging matters, the sign can be set to shut itself off at any hour desired.

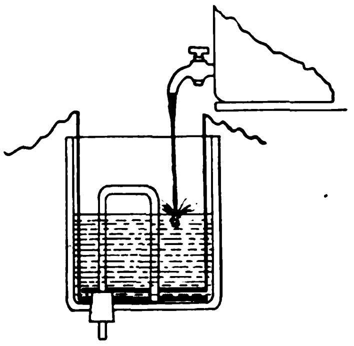


FIG. 3.—TANTALUS CUP SWITCH.

This arrangement as described would have the disadvantage that there would be a chance that the last cup of liquid would not reach the crest of the siphon, and would therefore remain in the cup, leaving the sign permanently in circuit. This may be obviated by placing a second set of contacts in the supply tank in series with the first. When the level of the supply tank had sunk below the contacts, the circuit would be broken and the hour at which this would occur could be regulated by raising or lowering the contacts in the tank.

A third set of contacts in the lower tank would make the device still more automatic. These contacts being in series with the sign circuit, it is plain that the latter could not operate till the level in the lower tank had reached a certain height, and that this time would be determined by the height of the contacts. This would enable the operator to start the flow and leave the sign, say, at 6 o'clock, and at 7 it would begin to run intermittently, according to the rate of flow and the height of the contacts in the tantalus cup. At 10 the sign would automatically shut itself off. This arrangement would be much appreciated by advertisers.

If these contact plates are properly made and the acid is proportioned for maximum conductivity, the drop will be found to be 2½ volts per set of contacts with 10 amperes flowing; therefore, the sign will have to be composed of lamps which are designed for a pressure of 7½ volts less than the voltage of the supply mains. The only objection is that this arrangement is the same as Edison's objection to a battery—it is wet. For this reason, and also for the reason that it generates to a certain extent corrosive gases, it should be placed in a cellar or in some similar locality where its presence will not be obnoxious or its manipulation troublesome.

ARMATURE WINDINGS AND CONNECTIONS.

BY PROF. ARTHUR L. RICE.

MULTIPOLAR WINDINGS AND TWO CIRCUIT CONNECTION.

NOTE.—In the March issue, the upper figure on p. 102 is Fig. 6—Four pole wave winding—the lower is Fig. 5—Four pole lap winding.

On multipolar armatures, as on bipolar, there are generally two or more layers of conductors. The majority of multipolar machines are at present built with formed coils, Fig. 1, and these coils are laid on one after another, one side of a coil—that is, one conductor on the connection diagram—being in the bottom of a slot under one pole, and the other side in the top of another slot in the corresponding position under an adjacent pole. Care must be taken, therefore, that a conductor in the bottom layer always joins to a conductor in the top layer, so that the coils may lay into place properly. For a 4-pole machine, with 48 conductors in two layers, and 24 commutator bars, the pitch for a lap winding may be taken as 11 back and 13 front, Fig. 2. The connection will then be as given in Table I.

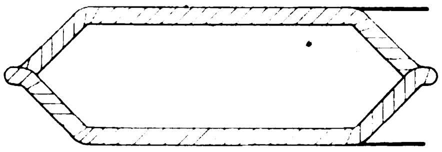


FIG. 1.—DRUM-FORMED COIL.

TABLE I.—MULTIPOLAR LAP-WINDING CONNECTIONS.

Bar	1	to	conduct'r	1,	back	to	conduct'r	12,	front
"	24	"	"	47	"	"	"	10	"
"	23	"	"	45	"	"	"	8	"
"	22	"	"	43 etc.					

As the even number conductors are all in the botttom layer, and the odd number in the top, the condition for proper laying of coils will be fulfilled. By tracing out the direction of the E. M. Fs., they are found to be in series, and it is also found that the brushes will go on at bars 1, 7, 13 and 19. In laying on the coils, conductors 2, 4, 6, 8, 10 and 12 must be put in place in the bottom of the slots before 1 can be placed; then coil 14-3 would be put in place, and so on in order around the armature. If the winding be examined it will be seen that the connection drops back one bar and one slot at each connection, instead of advancing as in other cases considered; this is because the front pitch is larger than the back, and the winding is called "retrograde" winding; the previous ones were "progressive" windings. There is no particular advantage in either type over the other.

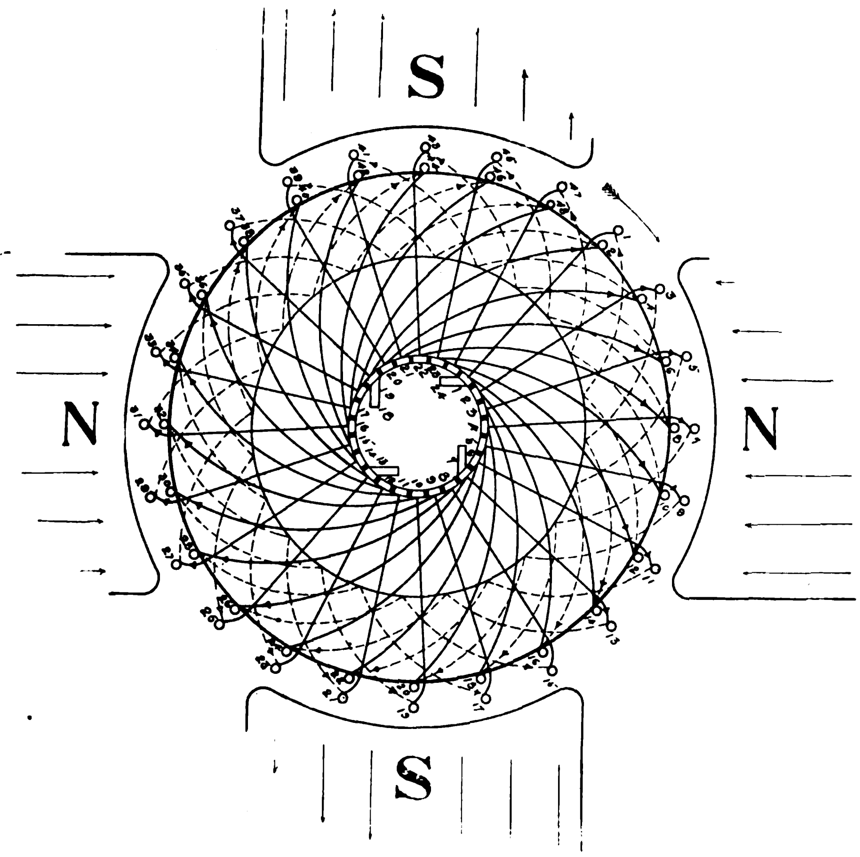


FIG. 2.—TWO-LAYER, FOUR-POLE LAP WINDING.

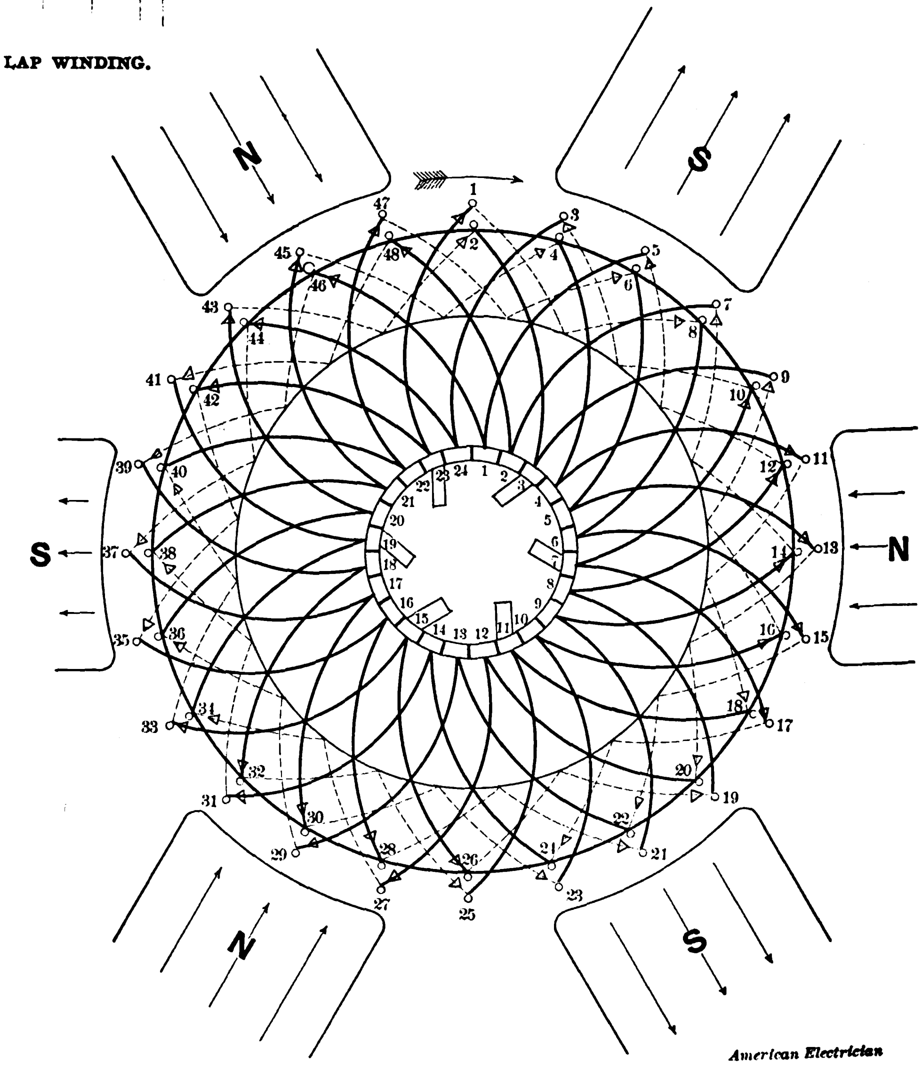
The winding for a machine having six, eight or more poles is the same in principle as for four poles. If it is to be a lap winding with as many circuits in parallel as there are poles, the number of coils must be divisible by the number of poles, that is, the conductors divisible by twice the number of poles, and the average pitch is best taken as the quotient of the conductors divided by the poles, though the front and back pitch may be taken at any two values whose average is the quotient thus found; generally the numbers next above and below the average are chosen. For a wave winding, the condition already stated must be fulfilled. If the armature is to have two layers of conductors, it is always best to connect a conductor from the under layer to one from the upper to form a coil, whether formed coils are used or not.

For illustration of a multipolar wave-wound armature with two layers, a six-pole machine with 48 conductors will be used, the machine to have six parallel circuits. By our condition for wave winding,

$48 + 6 = 54 = 6 \times$ pitch; pitch $= 9$, or,
$48 - 6 = 42 = 6 \times$ pitch; pitch $= 7$.

hence 9 or 7 may be the average pitch; let 7 be chosen. Also connection will be so made as to equalize the length of the connecting leads—that is, conductors which are to be connected on the front will both be joined to a commutator bar half way between. The connection will then be (see Fig. 3) from conductor 1 to conductor 8 in a coil; 8 is to be joined to 15, and bar 6 is nearest of any to being half way between, so that the lead from 8 goes to bar 6; thence the connection is to conductor 15, to conductor 22, to bar 13, to conductor 29, to conductor 36, to bar 20, to conductor 43, to conductor 2, to bar 3, and so on. By examination of the direction of E. M. Fs., it is found that the brushes go on bars 3, 7, 11, 15, 19 and 23; those on 3, 11 and 19 would be joined by a common connection to one main leading from the machine; those of 7, 15 and 23 to the other. Note that in going from one brush to another—for instance, from the brush on bar 3 to that on bar 7—eight conductors are joined up; this is one-sixth the whole number, so that there will be six circuits in all, as was intended.

The tendency in present day practice is toward high voltages. For direct current machinery, which is most commonly used in connection with isolated plant lighting systems, the limit is set by practice at



American Electrician

FIG. 3.—TWO-LAYER, SIX-POLE WAVE WINDING.

about 220 volts for three-wire and 110 volts for two-wire systems. For these voltages a multipolar dynamo or motor will generally be wound with as many parallel circuits as there are poles, according to the methods just described. When a circuit is to be used entirely or mainly for power transmission, it is better to use higher voltages, and 500 volts are commonly adopted. It is desirable to keep the speed low for the 500-volt machines and this means using a large magnetic flux or many conductors in series in each circuit.

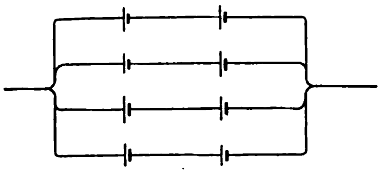


FIG. 4—FOUR-CIRCUIT BATTERY CONNECTION.

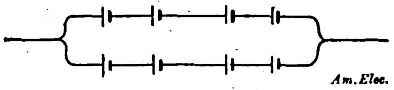

Am. Elec.

FIG. 5—TWO-CIRCUIT BATTERY CONNECTION.

From the manufacturers' standpoint it is necessary to be able to use the same frames for machines of all voltages; since the magnet cores will be worked well up to the saturation point when used for 110 or 220 volt machines, it will not be possible to increase the flux materially, and therefore the number of conductors in series must be increased in direct proportion to the voltage. This might be done by using many turns of small wire in each coil, and keeping the parallel method of connection. The use of many turns per coil makes the winding difficult and costly; also the space occupied by the coil for the high voltage armature must be about the same as that used for the low voltage coil if the same size armature is to be used; for many turns this means smaller wire, which is mechanically bad and uses up more space for insulation. On both accounts, increasing the turns per coil is an undesirable procedure.

There is one possibility left; to connect more coils in series and have fewer parallel circuits. This is analogous to the connection of coils in series or parallel for a battery. Suppose eight cells of two volts each are to be connected so as to give an e.m.f. of 4 volts, the connection would be as in Fig. 4. If it is desirable to get 8 volts, the cells will be connected with twice as many in series, and half as many parallel circuits as in Fig. 5. Since there must always be an even number of parallel circuits, four or six pole dynamos can be connected only as two-circuit machines in the series form; eight-pole machines might be connected with eight, four or two circuits; but, in practice, the two-circuit is the one used almost without exception.

The Gramme ring armature may be connected in the two-circuit form for multipolar machines, but must fulfill this condition; 2 x number of coils, plus or minus 2 = number of poles x average pitch.* Unless this condition be fulfilled the winding will re-enter upon itself before all the coils are connected.

Suppose that it is desired to wind a Gramme ring armature for a dynamo having four poles, and the design calls for 22 active conductors: $2 \times 22 + 2 = 4 \times$ pitch; $44 + 2 = 46 = 4 \times$ pitch: Or $2 \times 22 - 2 = 4 \times$ pitch; $44 - 2 = 42 = 4 \times$ pitch. In neither case would the pitch be an even number as neither 42 nor 46 is devisible by 4. But if two conductors be wound into a coil, the active coils to be connected are $22 \div 2 = 11$, and the condition becomes, $2 \times 11 + 2 = 4 \times$ pitch; $22 + 2 = 24 = 4 \times$ pitch, pitch $= 6$; or $2 \times 11 - 2 = 4 \times$ pitch; $22 - 2 = 20 = 4 \times$ pitch, pitch $= 5$; and either 5 or 6 may be used. Let 5 be chosen. There will be 11 commutator bars, as many as there are coils. The diagram is shown in Fig. 6.

For the sake of equalizing the length of leads, connections are made from each of two joined coils to a bar half way between. Conductors 1 and 2 are joined into coil I; 3 and 4 into II, and so on. The pitch of coils is to be 5, so I joins to VI, the leads going to bar 4; from VI the connection is to XI through bar 9, and so on as shown in Table II.

A coil under an S pole is joined in series with one under an alternate S pole and one under a N pole to one under a N pole. This is the principle followed in all two-circuit windings for multipolar machines. By tracing the direction of the e.m.fs. it is found that brushes are to go on bars 1 and 9. Since there are but two circuits, only two brushes will be needed. It will be noted that the path through coils III, VIII, II, VII, I and VI has six coils, while that through IX, IV, X, V, and XI has only five; with so few coils as are on this armature, serious unbalancing of resistance would be produced by this arrangement. The e.m.fs. generated would be equal since coil III is between poles and is not generating.

In practice no machine would be built with so few coils and, with a large number, no serious effects would follow the use of one more coil in one circuit than in the other. If, however, more conductors are wound up in one coil than in another, a peculiar result follows, especially in multiple-circuit Gramme ring, and in lap-wound drum armatures where the ends of a coil are joined to adjacent commutator bars. The coils having the larger number of turns will have a greater self-induction than the others, hence will require the brushes set with more lead to prevent sparking. If the machine is so wound that the coils are alternately large and small, blackening of every other bar will be produced; because if the lead be right for the larger coils, the smaller ones will spark, while if it be right for the smaller coils, the larger ones will spark.

TABLE II.

TWO CIRCUIT GRAMME RING WINDING.

Bar	to coil	to bar	to coil
10	I.	4	VI.
9	XI.	3	V.
8	X.	2	IV.
7	IX.	1	III.
6	VIII.	11	II.
5	VII.	10	I.

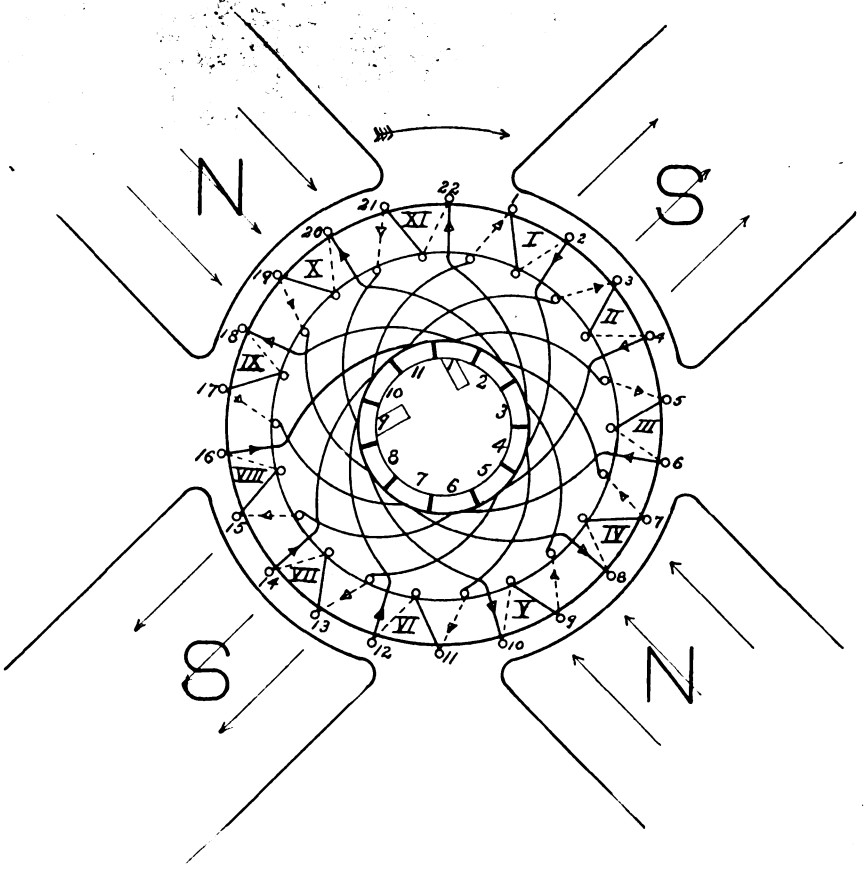


FIG. 6.—FOUR-POLE TWO-CIRCUIT GRAMME RING WINDING.

To return to Fig. 6 there are approximately half the conductors on the armature joined in series in each path; therefore the e.m.f. generated will be twice that produced if only one quarter the conductors had been joined in series. On the other hand, the armature can carry only one-half the current with the two-circuit connection that it could with the four-circuit. The same coils might be connected into either a four-circuit armature, for 230 volts and 50 amps., for example, or into a two-circuit armature for 460 volts and 25 amps. If 500 volts were desired, either the speed must be increased somewhat—but not probably beyond allowable limits—or the coils must be made of a few more turns of somewhat smaller wire.

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* More briefly, $2C \pm 2 = ny$ (In the March number the equation for wave wound multipolar drum armatures should have been $C \pm K = ny$.

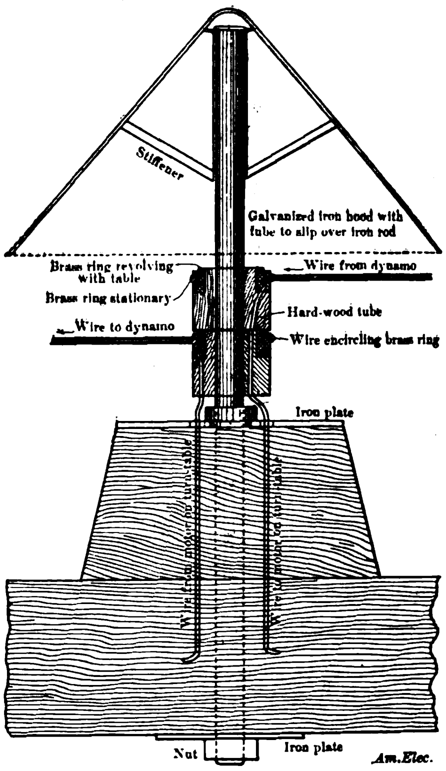
THE USE OF ELECTRICITY FOR TURNING LOCOMOTIVES AND CARS.

BY I. G. RAWN.

Gen. Superintendent. B. & O. S. W. R. R

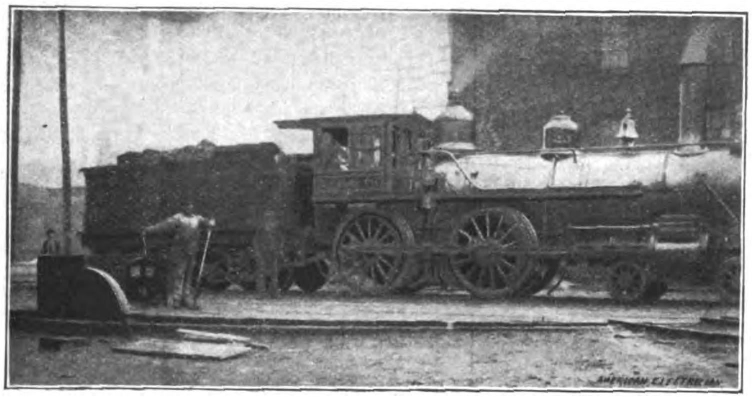
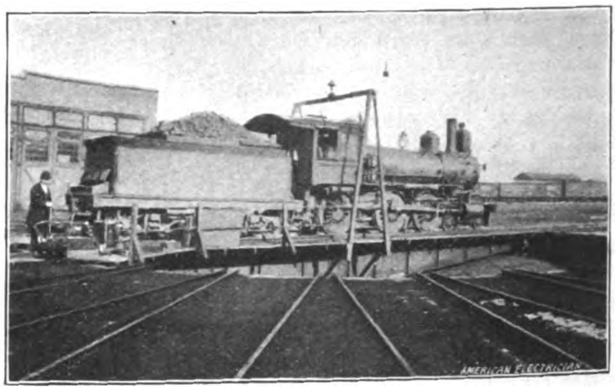
A source of much annoyance and no little expense is the turning of locomotives and cars at divisional points and terminals. Workmen are not especially employed for this service, but engine wipers and helpers about the engine house are called upon each time the turn table is used. The number of men that usually assist in this work is four, two at each end of table, and the time they lose from their regular duty is considerable, as they are frequently in the pit under an engine, in the engine house or on top of the engine or at some other inconvenient place to get away from when called; their movements are also apt to be slow, and they frequently engage in conversation when meeting, which takes up time that should be devoted to other purposes.

Our general master mechanic estimates that it costs 12 cents to turn each engine by hand. Observing these delays and the expense attending them, the writer about two and one-half years ago devised a plan for turning the 60-ft. turn table at Chillicothe, O., by means of an electric motor. This motor was applied to an old car wheel by means of cast iron spur gear wheels, so as to reduce the speed. The car wheel and motor were attached to a frame which was hinged to the girder of the turn table, the car wheel bearing on the circular rail or the track of the turn table. It was found that the weight of the frame, motor and car wheel was sufficient to give necessary adhesion, so that the tractive force would easily turn any engine. On trial we found that the heaviest engine could be turned completely around in fifty-six seconds.

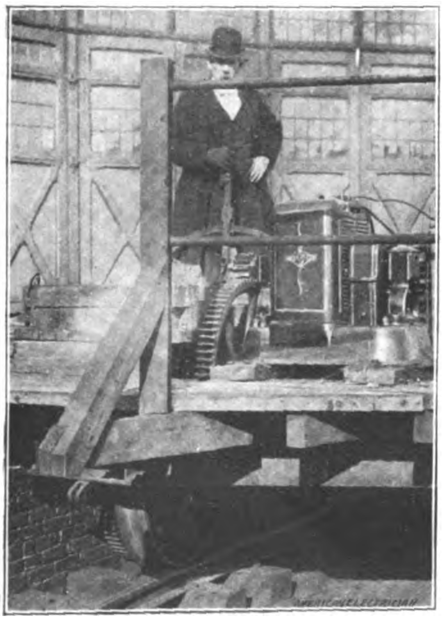

Stiffener
Galvanized iron hood with tube to slip over iron rod
Brass ring revolving with table
Wire from dynamo
Brass ring stationary
Hard-wood tube
Wire to dynamo
Wire encircling brass ring
Iron plate
Wire from motor on turntable
Wire to motor on turntable
Nut
Iron plate
Am. Elec.

DETAILS OF TURNTABLES.

The current is carried to the motor by an overhead wire which is connected directly over the center of the turn table by two brass rings, insulated with hard wood, so that a perfect contact is always given, thus furnishing a good conductor for the current to the motor. The current is controlled by a rheostat so that the motor can be run in either direction, and at such speed as may be desired; this is done by a single lever, which is moved back and forth. The cost complete, including motor, did not exceed five hundred dollars, and after two and one-half years' use, the device seems just as good as when constructed, and has given such good satisfaction that it was decided to operate the turntable at Park Street, Cincinnati, Ohio, in a similar manner, except that the current is taken underground and connection made around the center cone of the table, so that all wiring is concealed, thus presenting a neater appearance. A motor of from 5 to 7½ h.p. will furnish sufficient power.

ELECTRIC TURNTABLES.



OPERATING GEAR, ELECTRIC TURNTABLES.

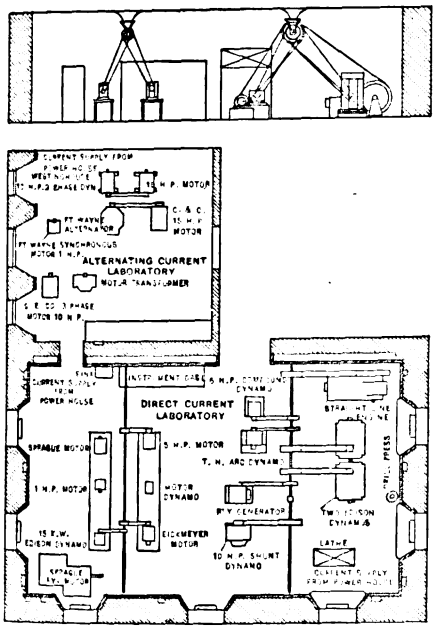
The electric power is purchased from the Union Depot Company at meter rate; the cost of this power for four months, viz., May, June, July and August, has been $29. All of the electrical equipment has been furnished by the Triumph Electric Company, of Cincinnati, Ohio.

This turn table is used on an average of fifty times each day, thus making a cost of less than one-half cent for each time the table is turned, while if it was operated by hand, using the figures of the general master mechanic (12 cents for each engine), it would cost $738, which shows a saving of $709, no cost being allowed for repairs; the repairs, however, will never be very expensive.

We have just completed a plan for equiping the turntable at Shops, Ind., with a device similar to the one in use at Chillicothe, Ohio, and will have it in operation in a few weeks. I think even a better showing can be made there than at Park Street, Cincinnati, as more use is made of the table.

COLUMBIA UNIVERSITY ELECTRICAL ENGINEERING SOCIETY.

The Electrical Engineering Department of Columbia University has been well supplied with facilities in the new buildings at Morningside Heights. The laboratories, lecture and other rooms of this department are on the south end of the engineering building, which flanks the laboratory on the west. In the sub-basement are located the storage battery and photometer rooms, the former containing a battery of 70 cells to be used for efficiency and output tests, and also as a source of steady and potential current. The photometer room is equipped with the necessary apparatus for determining the candle power of arc and incandescent lamps, as well as other sources of light. In the basement are situated two machine laboratories, shown in cross section and plan in the accompanying illustrations, the larger containing the direct current machinery, while the smaller accommodates the alternating current apparatus. In the former, a 50-h.p. high speed steam engine drives two lines of shafting carrying pulleys controlled by friction clutches, to which various machines are belted, the arrangement being such that two dynamos of 30 k.w. each can be connected to the engine; or either or both of the two machines may be used to drive the line shaft, the current being obtained from the electric light and power plant of the University. The various dynamos belted to the line shaft include examples of 115, 230 and 500 volt constant potential generators, constant current arc lighting machines and other typical machines. Several types of stationary and railway motors and motor dynamos are also placed in this room. Machine hand tools are provided in one corner of this laboratory for making and repairing apparatus, adjustments, etc. Complete sets of ammeters and voltmeters to speed indicators, transmission and absorption dynamometers are available for testing the various dynamos and motors. In the other machinery laboratory the alternating current apparatus is placed, including single and polyphased generators, induction and synchronous motors, as well as various types and sizes of transformers. Each generator is driven by its own electric motor, thus enabling its speed to be independently regulated. On the third floor are located the experimental laboratory and research room, containing a very complete equipment of galvanometers, standard cells, resistances, and, in fact, all manner of instruments used in measurement and research. A most important feature is the large and reliable supply of electric current afforded by the central power plant of the University. This consists of boilers of an aggregate capacity of 2000 h.p., two low-speed engines directly connected to dynamos of 275 h.p. each, and two high-speed engines directly connected to two dynamos of 100 h.p. each. Special conductors lead from this station to all the laboratories as well as the lecture rooms of the electrical engineering department, thus enabling an ample supply of current for experimental work to be obtained. In addition to the above laboratories, the student of electrical engineering receives instruction in the physical laboratories which occupy four floors of the Physics Building, and in the mechanical engineering laboratories, both of which are exceedingly complete in their equipment and facilities.



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COLUMBIA UNIVERSITY ELECTRICAL LABORATORIES.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Roller Bearings.—Some tests made upon roller bearings for the motor cars of the Liverpool elevated railway show, according to *Engineering*, excellent results. Each bearing carries eight rollers each 1⅝ ins. in diameter and 7 ins. long. The starting resistance on a level was found to be one quarter to one sixth that shown by ordinary bearings, while on a grade of 1-140 it was diminished 40 per cent.

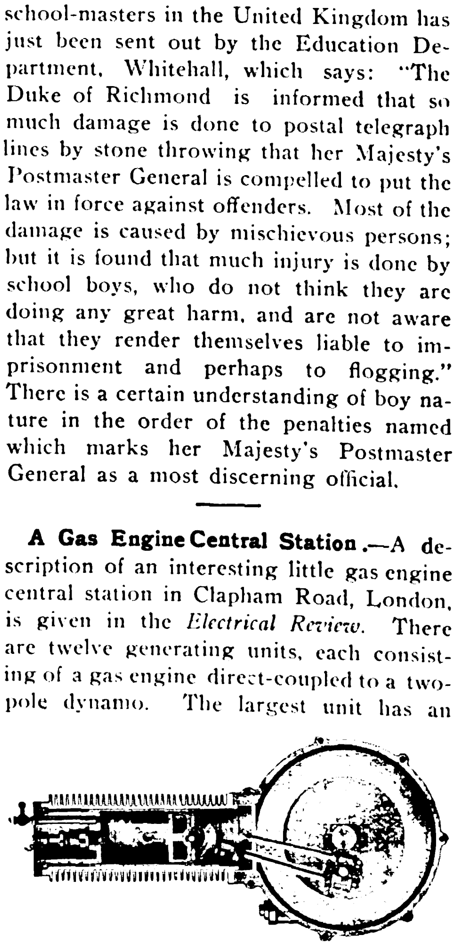
Light Accumulators.—A new type of accumulators for traction purposes has been brought out in England, says *La Revue Technique*, which is remarkable for its lightness. The negative elements are thin sheet-iron plates coated with lead. The electrolyte is a mixture of the sulphates of cadmium, magnesium and zinc. An element weighing only 8.16 pounds is said to have given 33 amp. hours discharge, the e.m.f. meanwhile falling from 2.4 to 1.9 volts.

Submarine Cables—The total number of submarine cables in the world is 1459, of which 1141 are coast and river cables belonging to governments. The total length of cable is 162,938 miles. Of this 143,024 miles are owned by corporations, 70 per cent of these companies being English. In time of war it has always been the custom for messages to pass without question through neutral States. During the recent war telegrams between Turkey and Greece were forwarded through Austria, direct communication being interrupted. In the war between China and Japan there was no interruption in the telegraphic service between those countries.

Ringing Church Bells Electrically.—Electrical machinery has been applied to the ringing of heavy bells at the church of St. George, Berlin, and the installation is briefly described in the *Electrical Engineer*. A shaft carrying three drums, upon which are wound the bell ropes, is turned by a 10-h.p. motor. The drums turn freely on the shaft, to which they may be clutched by a friction disc arrangement. The bells are of the swinging variety. When the motor is started and a bell drum clutch is worked by hand the bell swings as its rope is wound up, until at a certain point the clutch is released and it swings back and rings. This operation is then automatically repeated and the bell continues to ring as long as the motor runs. One man can attend the three very large bells in this way.

Stone Throwing and Telegraph Wires.—It appears that the British small boy is not unlike his American cousin in his stone-throwing proclivities. A circular to school-masters in the United Kingdom has just been sent out by the Education Department, Whitehall, which says: "The Duke of Richmond is informed that so much damage is done to postal telegraph lines by stone throwing that her Majesty's Postmaster General is compelled to put the law in force against offenders. Most of the damage is caused by mischievous persons; but it is found that much injury is done by school boys, who do not think they are doing any great harm, and are not aware that they render themselves liable to imprisonment and perhaps to flogging." There is a certain understanding of boy nature in the order of the penalties named which marks her Majesty's Postmaster General as a most discerning official.

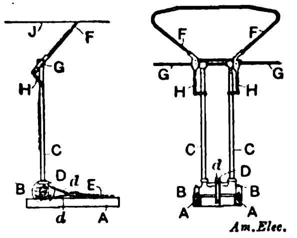
A Gas Engine Central Station.—A description of an interesting little gas engine central station in Clapham Road, London, is given in the *Electrical Review*. There are twelve generating units, each consisting of a gas engine direct-coupled to a two-pole dynamo. The largest unit has an output of 25 k.w. and the smallest of 2 k.w. Current is distributed in the immediate neighborhood at 110 volts, a storage battery being used to steady the voltage and tide over the peak of the load. Much the most interesting feature of the plant is the type of engine used. This is an Otto



SECTION OF GAS ENGINE CYLINDER.

cycle single-cylinder machine, the piston being geared by a sort of screw gear to the wrist pin so that it rotates once about its own axis for each two revolutions of the engine. In this way, ports in the piston are brought opposite proper intake and exhaust openings at the right moments. The piston is made very long. and is so arranged that the ignition of the gas takes place inside it, the cylinder walls not being exposed to the ignition temperature. The section of this novel gas motor shown here renders further description unnecessary.

A German Trolley.—In a recent bulletin of the Verein fur die Förderung des Local- und Strassenbahnwesens is given an illustrated description of a new form of the Siemens bow trolley. A frame *A* mounted on the roof of the car carries two bearings *B* in which the fork *CC* is hinged. This is furnished with a grooved pulley *D* around which are wrapped in opposite directions two metallic ribbons *d*. The free ends of these are attached to the spiral spring *E*, which is in turn attached to the frame *A*. By this arrangement the fork *CC* is kept always vertical, except in emergencies, when it has the necessary ability to deflect out of the way of obstructions. The bow *FF*, which bears on the trolley wire, is mounted, as shown in the illustration. When the car is reversed this bow engages with the trolley wire and is carried over to the corresponding position on the other side of *CC*. This trolley arrangement has been working for some months on the Chaux de Fonds tramway in Switzerland, and the success it has met with there has determined its application on several other lines in the neighborhood.



A GERMAN TROLLEY.

Safety Accumulators.—At a recent meeting of the St. Petersburg Electrical Society a novel form of accumulator was described by M. F. A. Jeremin. To obviate the undue formation of sulphate and the falling out of the filling composition of the plates, he fills the cell and the spaces between the plates, which are more widely separated than usual, with crushed glass. The sulphuric acid solution is somewhat stronger than the usual proportions and the cells, after filling, are hermetically sealed.

The Centennial of the Battery.—In 1899 there will be held an international electrical exposition at Como, Italy, to celebrate the hundredth anniversary of the invention of Volta's pile. Sig. E. Jona, in an article in *L Elettricita*, proposes that this should be made a special exhibition of batteries of all forms. For a long time the battery was the only source of electricity, and despite the perfection of dynamos, has yet many useful applications. By bringing together all the various types of batteries and properly classifying them, an exhibit of great interest would be secured. It would also be possible, he thinks, to thus amass a battery of perhaps 100,000 cells or more, with which a number of valuable and interesting experiments might be made. It seems rather unfortunate for the proposed exposition that its date falls between that of the Turin fair this summer, and the great show at Paris in 1900, and this suggests the thought that we might possibly dispense with a few of the international expositions that are being exploited every month or so.

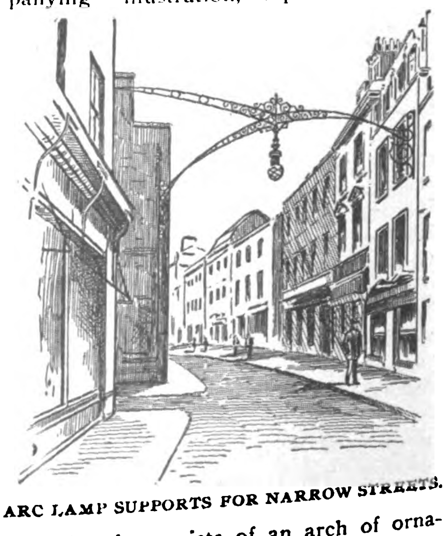
An Argentine Transmission Plant.—*La Inginiera* (Buenos Ayres) describes the fine electric light and power plant for Cordoba, Argentina. Power is derived from the falls of the Rio Primero, near Dique de San Roque, 13.6 miles distant. A tunnel 11 ft. in diameter and 295 ft. long through a hill connects two extremities of a great bend in the river. Water is taken from the tunnel to the turbines in an iron pipe 6½ ft. in diameter. The total available power developed is 5000 h.p. Current is transmitted to the city at 10,000 volts, three phase, the pressure being raised to this figure by transformers at the station. At the city limits it is reduced to 2000 volts and distributed in the usual way to customers.

The Tides as Motive Power.—An interesting little plant in which the rise and fall of the tides is used as motive power for the generation of electricity is described in *L'Electricien*. Near Ploumanach, on the northern coast of France, where the tides have a daily range of 39 ft., a small fish pond separated from the sea by a dike is arranged with gates so that at high tide the water flows in and fills it, the gates closing automatically when the tide recedes. The machinery of an old grist mill is used to operate a small dynamo, which charges a storage battery and furnishes light for the fish industry there. Another wheel in the same mill works an ice-making machine, the whole being under the charge of one man. It is stated that the total daily expense for generating about 2,000 h.p.-hours is only $2.

Measurements of Magnetic Field Intensity.—M. E. Bouty, in *Comptes Rendus*, describes a novel method for measuring the intensity of a magnetic field. A liquid conductor, which may be ordinary hydrant water, is made to flow normally to the lines of force of the field to be measured. The constant e.m.f. induced between the upper the lower surfaces of the steam is measured by a capillary electrometer and, from the known velocity and dimensions of the stream of liquid, the field intensity is calculated. For comparative measurements it is unnecessary to know the size or velocity of the stream so long as these are constant, which gives the method a practical value. The nature of the liquid used makes no difference in the result, and hydrant water, being readily obtained in large quantities and under pressures that will give high velocities or flow, is the best for practical use. The greater the velocity the greater the delicacy of the method. For very strong fields, where the sensitiveness of the electrometer is needlessly great, a standard condenser of two or three microfarads may be charged by the induced e.m.f. and discharged through a ballistic galvanometer. The only precaution necessary for comparative measurements is the thorough insulation of the electrodes in contact with the two surfaces of the stream. The polarization of these electrodes introduces no difficulties in the measurement.

A Dry Accumulator.—An electric miner's lamp of novel design is described in *L'Elettricita*, it being worked from two small cells of storage battery carried by the miner. The plates of this battery are built upon thin sheets of lead, which are provided with numerous projections to better secure the active material. This consists of a paste of finely powdered oxide of lead, mixed with a solution of india rubber, a solution of ammonia sulphate and some inert porous matter, such as powdered pumice, mica or mineral wool. The electrolyte is sulphuric acid. The inventor avoids the inconvenience that would follow the use of a liquid, without sensibly increasing the resistance of the cell, by the use of a paste made by boiling paper in sulphuric acid with small quantities of caustic potash and alcohol. The resulting material is dried and pulverized. When it is mixed with the electrolyte it swells and forms a semi-solid plastic mass.

Arc Lights in Narrow Streets.—At Dover, Eng., where the streets are very narrow and crooked, a novel form of arc lamp support has been devised and used with great satisfaction. As shown in the accompanying illustration, reproduced from *Lightning*, it consists of an arch of ornamental iron-work thrown across the street and supported from the buildings at either side. Where streets intersect the arch is in three parts, the lamp being over the in-



ARC LAMP SUPPORTS FOR NARROW STREETS.

tersection of the street centers and illuminating the streets equally in all directions. Alternating current is used, the supply circuits being underground. Where the lamps are mounted on poles the transformer is in the base of the pole. For the lamps suspended from arches it is installed in a manhole.

Permanent Carbons.—A Russian patent has been granted for the manufacture of permanent arc lamp carbons. They are composed of the purest carbon mixed with finely powered silicon carbide, some adhesive material such as molasses being used. A mixture of 90 per cent of carbon and 10 per cent of silicon carbide is said to be a good composition, though the proportions can be varied indefinitely. The electrodes can also be made with a core of the carbide, or the latter may be combined with any conducting material, such as carbon, to form the core. Since silicon carbide can only be produced by the action of a temperature approximately that of the arc, it contains no volatile ingredients and has the highest resistance to oxidation of all known substances. It develops a very intense light and, according to *L'Elettricita*, seems to promise excellent results. As the carbide is not a conductor, it is not possible to use it as an arc lamp electrode except in combination with carbon.

Death by Electricity.—There seems to be a wide variance of opinion as to the way in which powerful electric shocks produce death. Dr. W. S. Hedley, in a rather learned article in the *Electrical Review*, after stating the various theories on the subject, concludes that death by electricity can be accomplished by various physiological mechanisms. First, and perhaps oftenest, it may be by sudden arrest of respiration; it may also be brought about by sudden and primary stoppage of the heart action. In either case the result is not improbably due to physiological death of the centers of respiration or circulation, from chemical or other changes therein which present methods of observation do not permit us to recognize. The view, however, that death from electric currents is due to action upon the structure of the heart itself is very influentially held, and has never been disproved. The treatment recommended for those apparently killed by electric shock is artificial respiration, begun early and continued long. In proper hands the administration of nitrite of amyl may be productive of good results.

Resistances for Starting and Reversing Shunt Motors.—In a long article in *Elektrotechnische Zeitschrift*, Herr E. Egger describes a method for the control of motors which is said to be in very successful operation. The object of the method is to do away with the heavy starting current while the motor is accelerating and to reduce commutator sparking to a minimum. A series coil on the field, acting in the same sense as the shunt winding, is put in circuit in starting the motor. This increases the field strength and the starting torque and diminishes the starting current. When the motor is stopped, the armature is short-circuited in the strong field due to both coils, acting as a magnetic brake, and the discharge current of the shunt is minimized by the self induction of the series winding. Data of tests of this system in a building having six electric elevators show that the use of the auxiliary series winding reduces the starting current to almost one-half of that required before its adition to the motor. The first part of the article is a reply to a recent article by Menges upon the same subject, but contains nothing of special interest.

Prevention of Sparking.—A discussion in the German technical press of methods for the avoidance of sparking in the switches when stopping shunt motors has brought forward a number of novel ideas. The following simple and ingenious method is described by Herr J. Fischer-Hinnen in *Elektrotechnische Zeitschrift*: The shunt is connected across both the starting resistance and the armature, as shown in the diagram, and is consequently always short-circuited by the armature. At the moment of cutting out the motor the current due to self-induction in the shunt is closed through this path, and no arc whatever is formed at the switch. The effect of the resistance in circuit with the shunt is, of course, to slightly increase the speed of the motor, but it is pointed out that this only amounts to about 2 per cent with a properly proportioned resistance. The same arrangement can be used with series motors, which is a great advantage from the manufacturer's point of view.

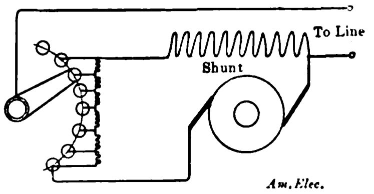


DIAGRAM OF MOTOR CONNECTIONS FOR SPARKLESS OPERATION.

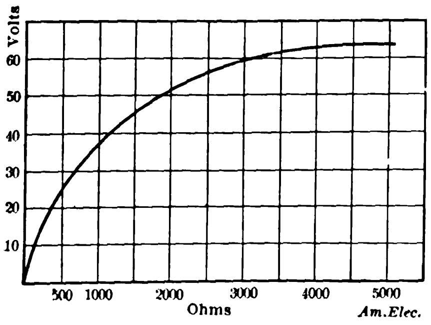
Chloride Accumulators.—An elaborate illustrated account of the process of manufacturing chloride accumulators appears in the *Electrical Review*. The principal interest centers in the making of the spongy lead negative plates. It is needless to say that no chloride of lead appears in the finished plate, its use being in the preparation of the spongy lead for the pellets of the negative plate only. The chloride is manufactured from litharge, which is dissolved in acetic acid and precipitated as chloride by hydrochloric acid. The precipitate is compressed to remove the excess of acid, dried, and subsequently melted in large iron pans lined with fire brick and containing a stratum of melted lead at the bottom. The molten chloride is cast into pellets for the plates, and these, while still hot, are set in a steel mold and melted lead forced in around them under a pressure of 150 lbs. per square inch. After the plates thus formed are scraped and trimmed they are set up alternately with rolled zinc plates in a bath, the result being that the chloride pellets are decomposed, leaving pure spongy lead in the grids, and the zinc reduced to its chloride. A thorough washing and exposure to a stream of hydrogen, which insures the complete reduction of the chloride of lead, leaves the finished plate ready for the attachment of the connecting cross bars.

Electric Mail Delivery in High Buildings.—At Geneva, a novel system for delivering letters in high apartment-houses is about to be tried. *L'Elettricita* describes it as follows: On the ground floor is arranged a cabinet having as many compartments or boxes as there are floors in the house. Depositing a letter in any box makes a contact that sets ringing a bell on the corresponding floor. This bell can only be stopped by removing the letter. The same current that rings the bell opens a valve connected with a water tank in the top of the house. Here are located cylinders attached by cords and pulleys to the letter-boxes below, and so arranged that when they are filled with water their weight serves to haul up the letter-box and its contents to the proper floor. When the box arrives, it is automatically dumped into another stationary letter receptacle, and at the same time the cylinder is discharged of its water. The letter-box then descends by its own weight to the ground floor and all is ready for the next visit of the postman.

Carbides of Sodium and Potassium.—In a communication to the Académie des Sciences, M. Henri Moissan stated that it is not possible to make the carbides of potassium and sodium in the electric furnace. M. Berthelot has already shown the existence of compounds having the formulæ C_2HNa and C_2Na, which are formed by the action of heat on sodium in an atmosphere of acetylene. The metals of the alkaline earths also form similar compounds under similar circumstances, according to M. Moissan. His conclusions in regard to the alkaline carbides are that both sodium and potassium form intermediate compounds, or acetylides, under the action of cold acetylene of the liquid gas, either at atmospheric or higher pressure, the compounds being C_2KH and C_2NaH. Upon being heated these decompose, acetylene being disengaged and the carbides, C_2K_2 and C_2Na_2 remaining. At a higher temperature the carbides are dissociated into the metal and carbon. The same phenomena may be observed with the carbides of the metals of the alkaline earths, but these require much higher temperatures. The conclusion is drawn that at the temperature of the electric furnace the carbides of sodium, potassium and magnesium are dissociated, and that these carbides cannot, on this account, be made in it.

Accumulator Mail Wagon.—For a month or more some of the mails between the general post office and Paddington Station, in London, have been carried in an electric mail wagon. Six round trips, a total of 35 miles, are made daily on one charge of the battery. Forty cells are used. each 6½ ins. square and 10 ins. high and containing eleven plates. The battery weighs 1456 lbs and has a capacity of 172 amp. hours at 30 amps. discharge. It is carried in a tray slung under the wagon. One motor, Lundell two-pole type, of 3½ h.p., is used. The armature has two windings and two commutators, and there are also two series field windings. Control is given by grouping these in five combinations, thus: (1) all the windings and a resistance in series; (2) the same with the resistance cut out; (3) two field windings in parallel and the armature windings in series; (4) the fields in series and armature windings in parallel; and (5) the field windings in parallel connected in series with the armature windings in parallel. The motor is connected through a differential gear and sprocket chains to the two rear wheels. These have a diameter of 3 ft. 6 ins. and are rubber tired. The *Electrician* says that the wagon has given punctual service and is very satisfactory.

E.M.F. of a Telephone Magneto.—Some experiments on the voltage of telephone calling magnetos are described in *Elektrotechnischer Anzeiger*. The magneto was of the usual form, having three steel permanent magnets of horseshoe shape, each ¾ in. wide, 4-10 in. thick and 5 ins. long. The pole pieces were of soft iron, 2¾ ins. long, their section being such as to embrace an arc of a circle. The armature core was of soft iron, having the usual double-T cross-section. The armature winding was of wire 0.15 millimetre in diameter (about No. 35, B. & S. gage), of which enough to bring the resistance up to 500 ohms. was wound on. Its coefficient of self induction was 2.7 henrys when the coil lay parallel to the lines of the field and 7.3 henrys when it was perpendicular to them. The driving mechanism consisted of a handle and two gears multiplying the speed 3.8 times. The magneto was one used by the Antwerp Telephone Company in its regular service. Measurements made with the armature making 15 turns a second showed that the magneto gave 65 volts on open circuit, its voltage rising with the non-inductive resistance in the circuit as shown by the curve. In this the ordinates show the volts and the abscissæ the resistances in circuit. No figures of the current output are given, and no indication of the shape of the current wave, which must be very different from the sine form.



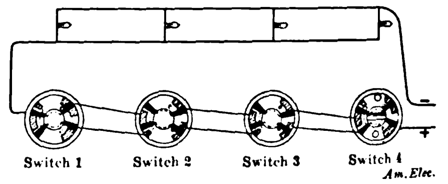
CURVE OF VOLTAGE OF A TELEPHONE MAGNETO.

Electrolytic Searchlight Mirrors.—In a paper read before the Institution of Electrical Engineers, Mr. Sherard Cowper-Coles describes a very rapid and cheap process for making parabolic or other curved reflectors by electrolytic means. A convex matrix of glass is prepared, of the precise form desired, and its surface polished and thoroughly cleaned. This is then silvered by the ordinary tannic acid and sugar process, a very thin and brilliant film of silver resulting. Upon this film copper is plated, very slowly at first in order not to destroy the exceedingly delicate silver coating, until its thickness is sufficient for mechanical strength. By placing the glass matrix in warm water the different expansion rate of the glass and copper loosens the metallic coating, which may be stripped off, the brilliant film of silver adhering to its inner surface. To prevent the tarnishing of the mirror which would immediately follow its exposure to the vapors of the arc, a coating of some non-tarnishable metal is electro-deposited upon it. Palladium is best for this purpose and easily plated. The palladium coating is not as brilliant as the silver, but remains unaltered after exposure to moist air and the fumes from the arc. The great advantage of mirrors of this sort over those made of glass and silvered on the back is that they may be penetrated by a rifle bullet without material injury to their reflecting power, where a glass mirror would be shattered to bits by such an experience. As the same matrix may be used over and over the process is also very cheap.

Volunteer Corps of Electrical Engineers—The English journals contain a set of rules for the government of the volunteer corps of electrical engineers connected with the military service of that country that would form an excellent basis for the organization of a similar corps in America. The English corps is recruited from an excellent class of artisans and engineers, and the officers and engineers of high standing, Dr. John Hopkinson being the major commanding. The corps wears the uniform of the Royal Engineers (Volunteers) and is armed with the Lee-Mitford rifle. Training is given to recruits in two branches, military work consisting of infantry drills, etc., and technical work including every application of electricity to war, except telegraphy. Each member must spend eight days each year in a defended port under training, which embraces signaling, fitting, loading, priming, and connecting up submarine mines and torpedoes, and a certain amount of boat work, knotting, splicing, etc. Enlistment is for three years, and non-efficient members are dropped at the end of the first year. Members are put to no expense, as the allowance made them covers the cost of their uniform, etc. The corps is said to be in a flourishing condition.

The value of such a body of trained electricians in time of war would be almost incalculable. The applications of electricity to warfare are nearly all of the defensive sort, and the possession of a corps of experts in such matters might prove of enormous importance to a country maintaining a defensive campaign or guarding a threatened coast. The value of such a volunteer organization to this country would be greater than to almost any other, because of the number and importance of the unprotected cities on our coasts, and the vital need for rapid and intelligent work should it be necessary to defend them. In no country would it be easier to enroll a body of competent electricians and electrical artisans. Already there is in existence a small corps of this kind attached to the National Guard of the State of New York, but it is only the beginning of what should be a far-reaching and efficient organization.

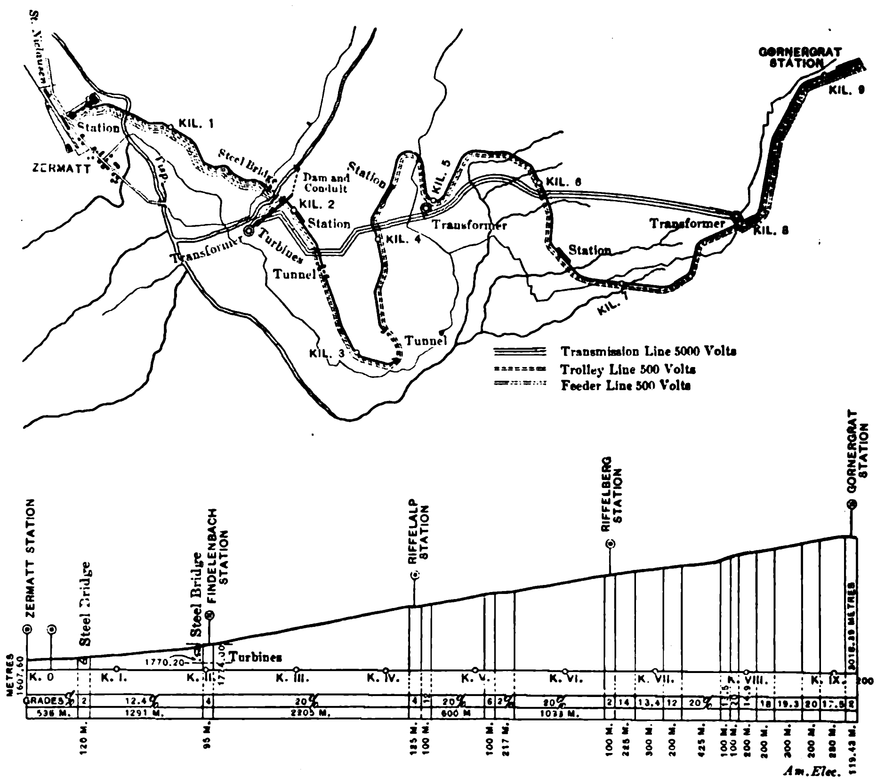
A Universal Switch.—It is frequently desired to control incandescent or other lights from any one of several places. as for example the case of lights in a stair hall, which could be conveniently lit by a switch on the ground floor and extinguished by one at the head of the stairs. No little ingenuity has been expended in the effort to perfect devices of this character, but one of the simplest and neatest that have yet appeared is described in *L'Energie Electrique*. The diagram is self explanatory, any one of the four switches operating to either light or extinguish the lamps and always leaving the system in order for subsequent manipulation. By using a relay switch in place of the lamps heavy currents can be handled, the individual switches being hardly larger than a lamp socket. Of course, any number of these switches can be used on one circuit without interference.



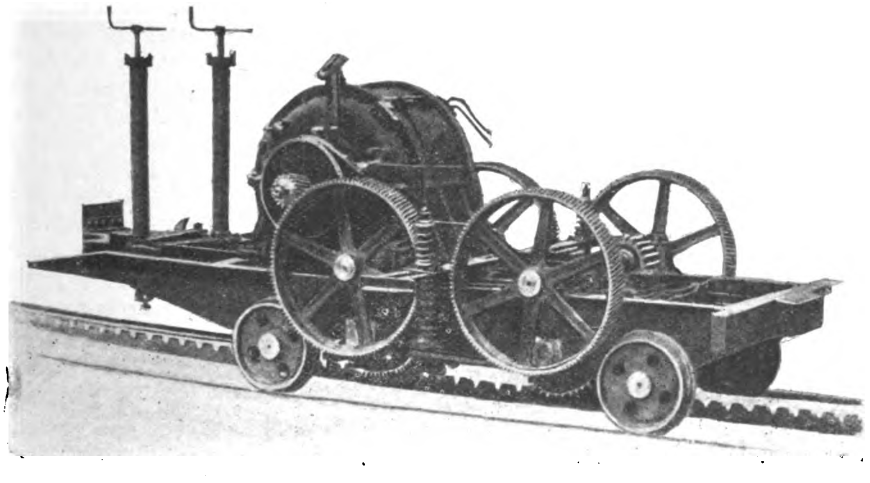
UNIVERSAL SWITCH.

Counter E.M.F. of the Arc.—A number of novel points of view are contributed to the literature of this subject by Mr. Walter D. Jameson in a letter to the *Electrical Review*. He criticises Blondel's method (an attempt to measure the e.m.f. between the carbons a very short time after the rupture of the main current) and postulates that if any counter e.m.f. persisted after the interruption of the main current for a definite time, say one *n*th second, then if, in the case of an alternating arc, the frequency be increased to *n* cycles per second the resistance due to the counter e.m.f. would decrease until it vanished, a manifest absurdity. If the persistence of the e.m.f. is a definite fraction of the time of the impressed e.m.f. it would tend to make the e.m.f. curve of the supply current "peaky," and introduce a harmonic into the curve. The contrary is well known to be the truth, the arc tending to flatten "peaky" curves. A new hypothesis is offered to explain the actions observed. It is that carbon, which is a tetravalent element, or one having 4 atoms in its molecule, at ordinary temperatures, becomes divalent at the temperature of the arc, each molecule splitting up into two others of two atoms each. Under these circumstances the formulæ for electrolytic action give a potential difference of 40.316 volts at the terminals of a 10-amp. arc, and this was very nearly the observed voltage in the case cited by the author. An experiment upon an arc with iron electrodes showed an exact agreement between the observed voltage, 27.18 volts, and that calculated under the above hypothesis, iron being like carbon a tetravalent element at ordinary temperatures.

A Three-Phase Railway.—An installation of an electric railway operated by three-phase currents and using induction motors has been undertaken and nearly completed under conditions of exceptional difficulty. The line extends from Zermatt to the Gornergrat, in Switzerland, a distance of 5.7 miles and in this short length rises 5248 feet. The heaviest grade is 20 per cent. A rack rail of the Abt system is used throughout the entire length of the road. Power is generated by three high-pressure horizontal shaft turbines of 250 h.p. each at 400 r.p.m., direct-connected through elastic couplings to three-phase generators of the fixed armature type. These machines furnish current at 5400 volts with a frequency of 40 cycles per second. This high tension current is transmitted over lines of three wires, each slightly smaller than No. 3 B. & S. gage, to two transformer sub-stations on the line of the road, at each of which is installed two sets of three 30-kw. single-phase transformers, the whole substation having a capacity of 180 kw. There is also a transformer outfit of the same capacity at the generating station. The line is fed from these at a pressure of 540 volts. Feeders of No. 0 wire are used on two sections of the line. Two trolley wires and the rails form the circuit, the trolley wires being suspended 16 ins. apart over the center of the tracks. Chicago rail bonds are used. The rails are of the Vignole pattern, were necessary, as shown by the map, which is taken, as are the figures given here, from *Le Genie Civil.* The principal point of interest about this installation is the motors. There are three locomotives, each equipped with two 90-h.p. induction motors. The two motors are entirely independent, each actuating one pair of wheels. Their speed of 800 r.p.m. is reduced by a double reduction gearing, the normal speed of the locomotive being a little less than five miles per hour. Control is effected by resistance inserted in the secondary or rotor circuit of the motors, collector rings being provided for this purpose. The locomotives start under full load with a current consumption no greater than that normally taken at full speed. They start a fully loaded train from rest on the heaviest grades with no difficulty. A most elaborate system of electric brakes and hand brakes is provided, but the motors become generators and restore energy to the line at speeds only slightly above synchronism, and fully loaded trains weighing 31 tons have descended the road with no other retardation than that afforded by this action, and at a speed but little greater than the normal ascending speed. Although the road has not yet been completed for its whole length the part of it that is in operation is entirely successful, and shows that for this sort of work the three-phase system is admirably adapted.


St. Niclausen
Station
ZERMATT
KIL. 1
Steel Bridge
Dam and Conduit
KIL. 2
Station
Transformer
Turbines
Tunnel
KIL. 3
Tunnel
KIL. 4
Station
KIL. 5
Transformer
KIL. 6
Station
KIL. 7
Transformer
KIL. 8
KIL. 9
GORNERGRAT STATION
Transmission Line 5000 Volts
Trolley Line 500 Volts
Feeder Line 500 Volts
ZERMATT STATION
Steel Bridge
Steel Bridge
FINDELENBACH STATION
Turbines
RIFFELALP STATION
RIFFELBERG STATION
GORNERGRAT STATION
METRES 1607.60
1770.20
2018.88 METRES
K. 0
K. I.
K. II.
K. III.
K. IV.
K. V.
K. VI.
K. VII.
K. VIII.
K. IX.
GRADES
12.4%
20%
20%
20%
13.4
19.3
17.8
536 M.
1291 M.
2205 M.
600 M
1033 M.
120 M.
95 M.
185 M.
100 M.
217 M.
225 M.
300 M.
200 M.
425 M.
280 M.
119.43 M.
Am. Elec.

MAP AND PROFILE OF ZERMATT-GORNERGRAT RAILWAY.

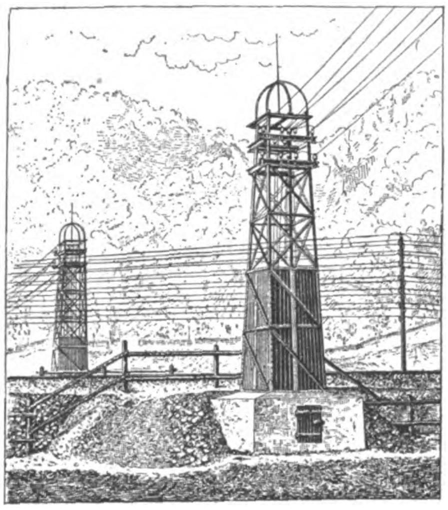


THREE-PHASE LOCOMOTIVE TRUCK, ZERMATT-GORNERGRAT RAILWAY.

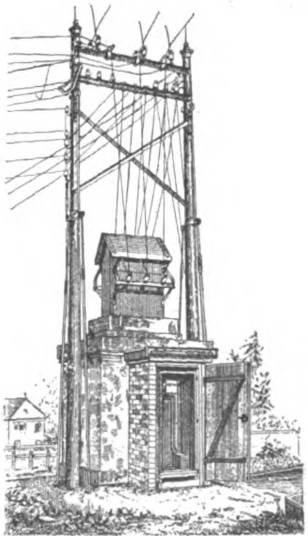
Polyphase Motors for Traction.—In a lengthy editorial the *Electrician* sums up the case against the induction motor and advocates the direct current motor for street car work. It says that the great difficulties of a double overhead wire circuit and of limiting the voltage drop in the earth return have not been sufficiently considered. In Europe the objections to a single overhead wire have retarded the development of electric traction, and the opposition to a double wire system would be prohibitive. Great trouble would be caused by induction from an alternating system in which one conductor is 20 ft. or more from the others. The power-factor of an induction motor is only 0.85 at full load and the transmission efficiency for a given output of the motor would be only about 73 per cent of that of a direct-current motor at full load. The average power of the motors in service is only about one-third of their rated power and the average transmission efficiency of the polyphase system would be only about one-third to one-half that of the direct-current system. The sub-stations in an alternating system would have to be of a sufficient capacity to meet the maximum load that would be likely to occur in the section that they feed, and hence the fixed losses of transmission would be relatively large. Of the various methods of speed control suggested none seem to be satisfactory. The rheostatic method requires collector rings and these need attention and inspection. The controller would be large and complicated and there would be difficulty in dealing with the arcs at the contacts, since magnetic blowouts are not reliable with alternating currents. Control by the "concatenation" two-motor method, where the stator of one motor is fed by currents induced in the rotor of another, is dismissed on account of the troubles due to the increased self-induction of the system, decreasing the power factor and diminishing the maximum torque. A variable voltage transformer on the car diminishes this defect, but this method is unsuited for city working where long runs must be made at low speeds. The commutator of an ordinary car motor costs only $20 to $30 and runs some 100,000 miles before wearing out. The conclusion drawn by our contemporary is that the polyphase motor will not replace the present commutating machine, but that the continuous current system will be greatly developed.

Unfortunately for these arguments they are largely based on incorrect assumptions. Nothing is said about the ease of working polyphase conductors in a conduit, nor is any mention made of the possibility of using a considerable drop in the track returns without causing serious electrolytic disturbances. As railway systems extend the direct current and feeder system must give way to the alternating even if the direct current motors are retained and the line fed through rotary converters. Here, however, is the opportunity of the polyphase car motor, and while it is true that at present the speed regulation methods proposed are not entirely satisfactory, the urgent need for better ones will almost certainly result in their appearance. Nobody proposes to immediately supersede the commutator motor, but it cannot be denied that its commutator and that of the generator are the weak points of the present system, and that the induction motor possesses the inestimable advantage of being as "simple as a grindstone." The sub-stations where the voltage is lowered for the motors need not be very large, since they may be interconnected and an excessive load occurring at any point distributed among several of them.

Power Transmission Lines in Switzerland.—Among the numerous Swiss installations for the electrical transmission of power, that in the neighborhood of the Lake of the Four Cantons presents some of the most interesting features, both on account of its magnitude and the novelty of the methods employed. The generating station is at Schwyz, where a natural fall of the river Muota is used as a source of power. Five horizontal turbines of 600 h.p. each are direct-coupled to three-phase alternators giving 8000 volts directly. The precautions against the destruction of the wheels by sand and gravel in the water, like the rest of the hydraulic features of the plant, are of the highest order and are very fully described by M. Henry Martin, in *Le Genie Civil*, from which the accompanying illustrations are taken. Perhaps the most interesting part of the installation is the line work. This is all aerial, bare copper wires being used throughout for both primary and secondary voltages. The lines extend to sixteen towns at present, and later will be built to Lucerne, 22 miles away. The longest line now operated is about 10 miles in length. Pine poles of various lengths are used, the insulators being of porcelain, double petticoated, 6 ins. high and 4 ins. in diameter and weighing about 5½ lbs. These are attached to the pole by a hook-shaped iron bracket which goes through the pole to a nut on the opposite side. Each pole tip carries a cast iron head from which a copper point projects, the whole being earthed through a stout bimetallic wire. At crossings over ordinary roads a double pole is planted at each side and a net of stout steel wires constructed from pole to pole under and about the three high tension conductors, so that if one of them breaks it cannot possibly fall into the road. At railway crossings a still more elaborate arrangement is used. Towers are built on each side of the tracks and a tunnel under the railway connects them. The conductors come down through the central part of the towers and are led through the tunnel on insulators attached to its masonry roof. The lower parts of the towers are of iron plate. Sub-stations are uniform in construction, and consist of a vaulted structure of concrete, about 8 x 10 ft. in plan and 8 ft. high. This is surmounted by a sheet iron chimney for the conductors. On each side of the structure is erected a pole, the two being connected above by an iron beam carrying the insulators. Three transformers are in each sub-station, their connections being the usual triangle. They are wound to give 240 volts in each phase of the secondary. A peculiarity of this installation is that lights are operated from one side of the three-phase system, this being consequently unbalanced. The transformer from whose secondary lights are to be fed is, of course, larger than the other two in the same sub-station, and is provided with a terminal from the middle of its secondary coil. The lighting circuits are three-wire, with 120 volts between each side and the neutral. The whole installation, complete with water power developments, station, lines, and rights of way cost only $160 per h.p. Power is sold at prices ranging between $26 and $56 per year, and 16-c.p. incandescent lamps are supplied with current at $4.40 a year.



HIGH-TENSION LINES CROSSING A RAILWAY.



A SWISS TRANSFORMER SUB-STATION.

Steel for Permanent Magnets.—In a recent contribution to *Comptes Rendus* Mme. Sklodowska-Curie describes a number of experiments undertaken to determine what varieties of steel are most available for making permanent magnets. Bars 20 c.m. long and 1 c.m. square were used and measurements were also made upon closed magnetic circuits in the form of rings. The bars were heated in a helix of platinum, made incandescent by an electric current and tempered in water. The magnetism thus induced was removed by a magnetized needle. The conclusion reached was that the quality of magnet steel is determined by the intensity of the residual magnetization in a closed magnetic circuit, and by the coercive field necessary for the demagnetization of the specimen. Of steels with varying proportions of carbon, those having about one-half of 1 per cent are best for magnet making. The presence of small quantities of various metals was found to have little effect upon the residual magnetization of a closed ring, but frequently increased the coercive field, and hence, better fitted the steel for use as a permanent magnet. Silicon, boron and manganese in small quantities were found to have practically no influence on the quality of the steel, while an admixture of a little nickel, chromium or copper seemed to improve it. The best steels, however, were found to be those containing small proportions of tungsten and molybdenum. The coercive fields necessary for demagnetization vary in the proportion of sixty for carbon steel, seventy-four for tungsten steel and eighty-five for molybdenum steel.

Electrical Drainage—A rather primitive installation for the drainage of the delta of the river Memel, in Prussia, is described at length in *L'Elettricita*. The district drained comprises about 45,000 acres, for the most part lying about 3 ft. below sea level, and protected by dykes. There are six pumping stations operated from a central generating station, steam being the motive power. Three-phase currents at 5000 volts are generated by two inductor-type dynamos of 160-kw. each, direct-connected to compound engines. Two exciters, each capable of furnishing current for both main dynamos and the station lights, are employed, one being driven by a small engine and the other by a synchronous motor connected with the main circuit. At the sub-stations, which are all alike, the pumping arrangements are very primitive, but very satisfactory for the work required of them. The water is raised by a large paddle-wheel running in a concrete setting (almost precisely a breast wheel, but reversed and acting as a water lifting machine). The average lift is only 3 ft., and the maximum lift 6 ft. The wheel is 26 ft. in diameter by 5 ft. 6 ins. face, and is provided with a cast steel countergear meshing with the pinion of a reducing train connected with the motor. This is of 75 h.p., of the synchronous variety, and takes the line voltage of 5000 direct without transformation. The motors work at 590 r.p.m. and the paddle wheels at 2.6 r.p.m., delivering at that speed 3600 cubic feet of water per minute. When it is desired to start up one of the pumping stations it is necessary to shut down the central station and connect the line to the motor upon the main switchboard, each pumping station being provided with a separate transmission line. Then the main dynamos are started up slowly, the synchronous motor keeping step with the current as the frequency rises. The whole installation is a curious mixture of old and new engineering methods, but it is probably as satisfactory as a more elaborate plant would be, and has the further merit of having been erected at a very low cost.

Synchronizing Alternators.—It is well known that if synchronizing transformers are improperly connected, the synchronizing lamp may be brightest when the machines are completely out of phase. To determine if the connections are properly made H. E. M. Kensit gives in the *Electrician* the following simple tests:

Referring to Fig. 1, which represents the case where the transformers are across only one coil of each armature, let AA represent double-pole bus-bar switches, and assume machine No. 1 to be running. Disconnect at B and C and connect the transformer terminals B and C to B' and C' respectively. Then if the lamp is bright when machine No. 2 is brought up to speed, the connections as shown are correct. If not, one of the transformers must be reversed.

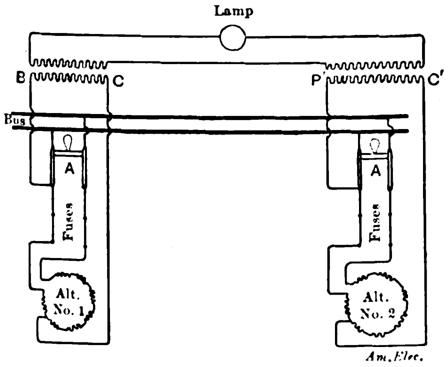


FIG. 1.—SYNCHRONIZING ALTERNATORS.

Fig. 2 shows the case when the transformers are connected directly across the alternator terminals. Take out the fuses of No. 2 and close the switch. If all is right the lamp will be bright. If the lamp remains dark one transformer must be reversed.

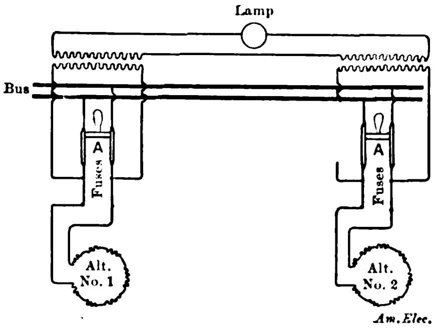


FIG. 2.—SYNCHRONIZING ALTERNATORS.

In cases where the synchronizing transformers are fed off only one coil of one machine and off the terminals of the other, a different arrangement is necessary, as shown in Fig. 3, the temporary use of another transformer being required. This should be connected up as shown by the dotted lines. Disconnect the leads B', C', D', and E' and connect D' to F and E' to G. Then run No. 2 machine up to speed. If the lamp is not bright reverse the high tension leads to the temporary transformer. Then disconnect the leads D' and E' from F and G and secure them in their proper places and connect up the coil B'C'. Now proceed as in the first case and, disconnecting at D and E, connect D to F and E to G. If the lamp is not bright reverse the leads at B'C' and replace the leads at D and E. Having now proved that No. 2 machine is ready for being thrown in by the use of the temporary transformer, and that the transformer fed from one of its coils is in correspondence with the temporary transformer, the latter may be removed and the machines paralleled by means of the switchboard transformers with every confidence. With machines having small self-induction some method of this kind is recommended as decidedly less dangerous than the usual method of trial through a long light fuse.

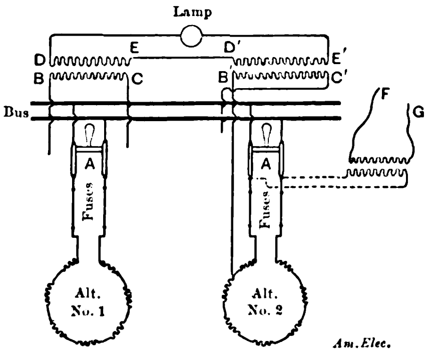


FIG. 3.—SYNCHRONIZING ALTERNATORS.

Electrolytic White Lead.—Up to the present the old Dutch process for making white lead (lead carbonate), writes Mr. Sherard Cowper-Coles in the *Electrical Review*, has held its own as the best, and the excellence of the product resulting has kept it the standard method of manufacture despite its slowness and expense. This process consists of subjecting grids of pure cast lead to the action of acetic and carbonic acid vapors. In a large cubical brick stack a layer of tan-bark is put down and on this are arranged as closely as possible a layer of stone pots filled with dilute acetic acid. Over these are laid several layers of the lead grids and the whole covered with planks. Upon these planks is built up another layer of tan-bark, pots and so on until the stack is full. All ventilating apertures are then closed and the stack left to itself for from 10 to 15 weeks. The process of change from the metallic lead to its carbonate is not well understood. The tan-bark ferments and heats, giving off carbonic acid and volatilizing the acetic acid. When the stack is opened the grids are wetted and rolled to free them of the white lead which has formed on them. The process is necessarily very slow and expensive. A modification which reduces the time of the operation to five weeks is to put the lead, in the form of sheets, in crates with carbon plates to which the lead is connected by tin strips. The warm vapors start an electrolytic action between the lead and carbon, hastening the corrosion of the lead. Another electrolytic process consists in electrolyzing a 10 per cent solution of sodium nitrate in a wooden cell, the anode being pig lead and the cathode copper. The lead dissolves as nitrate while caustic soda forms around the cathode. The mixture of the two solutions precipitates the lead as hydrate, from which the carbonate is made by the action of sodium carbonate or bicarbonate. The process is regenerative and continuous. Another process is to use an anode of lead in a solution of a salt of ammonia and any acid that will produce a soluble lead salt, and of a bicarbonate of an alkali. A soluble lead salt is produced and precipitated as the carbonate by the free carbonic acid liberated at the cathode by the action upon the alkaline bicarbonate of the caustic ammonia there set free. The bath is regenerated by a stream of carbonic acid gas.

WHAT IS ELECTRICITY?

Some of the views expressed in an article in the March issue, entitled "Electricity," not being in accordance with those popularly held, proofs of the article were sent to a number of eminent electrical authorities, with a request for criticism, and below are printed the communications received in reply.

In the article it was stated that the smallest electrical wave thus far measured was 8 ins. This is an error, as waves one centimetre long have been observed, which length corresponds to a frequency about one ten-thousandth less than that of a wave of light.

In referring to the effect of frequency on the resistance of conductors, it was stated that "with very high frequencies electrical energy cannot be transmitted by means of wires, owing to the increase in the apparent resistance of conductors at high frequency." The qualifying word "commercially" should have followed "cannot," and "solid" preceded "conductors." With a frequency corresponding to a wave length of one centimetre, the flow of current would be practically confined to near the surface of the conductor, with the consequence that the drop through a solid No. 0 conductor would be about 7000 times greater than if a direct current of the same value were flowing. By using, however, hollow conductors, this effect is very largely decreased. The effect of circuit inductance was not mentioned, as this may theoretically be neutralized by capacity. Should it not be practicable to do so, the inductive drop, since it increases directly with the frequency, would in itself prohibit the use of high frequencies.

To the Editor of American Electrician:

I have read the proof of the article on what is electricity, and completely agree with the views expressed therein.

Chas. P. Steinmetz.

Schenectady, N. Y.

To the Editor of American Electrician:

I have read the proof of the article entitled "Electricity" with great interest.

It seems to me an admirable presentation of the attitude of scientific men toward the question, "What is Electricity?" and I think that it cannot fail to do good in encouraging a spirit of research into the relations of the manifestations of energy, and in repressing the tendency of untrained minds to philosophize beyond the limits of their possible knowledge.

John Trowbridge.

Cambridge, Mass.

To the Editor of American Electrician:

In accordance with your request, I have read over the proof of the article sent to me, and find the views expressed therein to be sufficiently orthodox. You make therein a number of eminently sensible remarks, such as those in the second paragraph, and the conservative tone of the article is to be commended. The popular idea that the domain of electrical phenomena is more mysterious than that of gravitation and other parts of physics, cannot be too strongly combated.

Arthur Gordon Webster.

Worcester, Mass.

To the Editor of American Electrician:

I think that you answer the question according to present knowledge. A physicist uses the words "light," "sound," "heat," in an objective sense, and also in a subjective sense. In the objective sense, light, sound, heat, are not agents or forces, but forms of energy; in the subjective sense they mean certain sensations, forms of physiological energy. In the case of electricity, the word is not so apt to be used in a subjective sense, as it is not perceived without artificial means, but in the objective sense it means nothing but electrical energy. Those who seek after a "juice," or an agent, or a force, do not understand the modern doctrine of energy.

I think that the terms of the comparison about the No. 0 conductor should be made more clear.

Further advance in knowledge of the constitution of matter and of the ether, and of the nature of molecular and ether motions, is bound to increase skill in controlling and directing the transformations of energy, but, as you show, there are limits which may be more and more approached but cannot be reached, far less surpassed.

Alexander Macfarlane.

South Bethlehem, Pa.

To the Editor of American Electrician:

I have glanced over the galley proofs of your article on "Electricity," and have no criticisms to offer, but I should think, with reference to the last paragraph, that while electrical energy is certainly the reality with which we are all principally concerned, it is quite possible that an electrical charge is an entity, in addition to, and apart from, the electrical energy which accompanies it. In other words, a charged insulating metallic sphere may, perhaps, not only be the focus of electrical energy in the surrounding ether, but may be, possibly, the seat of an entity even if this entity be not a substance. In this sense, electricity might be a reality as distinguished from electrical energy. Thus, if it could be shown that electrostatic flux consisted of a particular kind of stress or displacement in the ether, then the charged sphere would be surrounded by a distribution of this displacement. The displacement itself might be called electricity, while the energy contained in the displacement would be electrical energy. Of course, this is still, unfortunately, all speculation.

A. E. Kennelly.

Philadelphia, Pa.

To the Editor of American Electrician:

In the main I quite agree with the opinions expressed in the article, entitled "Electricity,"at any rate, so far as the practicable possibilities of the immediate future are concerned. I would only add that though much must be discovered, and much investigated before such things can be practically attained, still, I do not despair of the possibility some day, not only of light without heat, and of the electric transmission of power on a large scale without wires, but also even of the obtaining of energy by other means than the oxidation of carbon, or the utilization of water and wind power, say directly from the radiations that come to us from the sun, or from other sources internal or external to the earth. Probably, however, these are matters for succeeding generations, not for our own.

A. A. Campbell Swinton.

London, England.

To the Editor of American Electrician:

I have carefully read the proof of your article and think it is admirably written and covers the subject very fully. I could not suggest any improvements, unless it should be to modify the statement in regard to electrical energy being the "only entirely new form of energy with which man has become acquainted within historic times." The energy liberated by the thunderbolt has probably been known to men as long as heat or light has been known. The only difference, it seems to me, is that man has only recently learned how to economically generate, apply and control electrical energy. But this is equally true of some forms of potential energy, such as chemical energy. It can hardly be said that chemical energy was really known to man one hundred years ago, though the forms of energy resulting from its transformation were well known. I do not think there is any danger of adverse criticism, however, on your statement.

Philadelphia, Pa. C. J. Reed.

To the Editor of American Electrician:

The article in your March issue entitled "Electricity" takes a view of the case which has been held by the writer, in substance at least, for some years past. It is interesting in this connection to call attention to the tendency of human thought to move in a closed current, so to speak, and to explain *A* by referring it to *B*, and then after a while to explain *B* by referring it to *A*.

Throughout the whole course of electrical discovery, as may be seen by reference to Mr. Benjamin's "Intellectual Rise in Electricity," each new discovery was used, either by its discoverer or by somebody else, as the foundation for an explanation (I will not say theory) of some well known phenomena—for example, Gilbert's explanation of the rotation of the earth by magnetic attraction. Of late years it is somewhat fashionable to attempt to explain electrical phenomena by means of other phenomena not heretofore considered electrical, and when the average man asks what electricity is, he wants to be answered, it is matter, it is energy, or some such answer, and he is not satisfied with any other kind of reply. Yet at the same time the ancient idea of explaining other things by means of electricity still retains a hold on the mind of the multitude, as for example, "electricity is life." This brilliant remark was made by Napoleon to his physician, Corvisart, on witnessing an experiment performed by Volta upon a corpse. This practice of constructing reversible or cyclic explanations has not, up to the present time, advanced electrical or other science in any marked degree, yet it has not entirely lost its popularity.

Townsend Wolcott.

New York.

To the Editor of American Electrician:

I received a copy of proof on the subject of "What is Electricity?" and think you are quite right in assuming the attitude you did, and, so far as I can see, the views you put forward are perfectly reasonable.

I have never had any sympathy for the tendency in the popular mind to surround electricity with an air of mystery, more than to so surround the operation of other natural forces, for they are all equally mysterious; in fact, I think, as a matter of philosophy, if the truth were really known to us we should find that electrical actions were probably far simpler than what we regard as purely mechanical ones.

The very simplicity of electrical laws seems to point to the fundamental character of the actions. The ether of space is an electromagnetic medium, i. e., its properties are apparently altogether electromagnetic; and believing, as I do, that the material universe is based in some way upon the ether of space, I am naturally led as a matter of philosophy or speculation to think that if we could see far enough we should find that gravitation, cohesion, inertia, and other mechanical forces and properties, as well as chemical attraction, were, in some way, dependent upon the electromagnetic properties of ether; and if we really understood the meaning, or could form in our minds an image of electrical actions, we should have the key to nearly all others.

This view is not in response to any desire to make all things electrical, or regard them as all based upon electrical manifestations. My own training, in fact, has been fully as much a mechanical training as it has been an electrical one, and for years I had charge of chemical teaching in the High School of Philadelphia. There is no reason why I should be predisposed towards the mechanical, electrical or chemical theories, in preference to each other; but I am growing in the conviction that attempts to explain electrical and chemical phenomena by mechanical analogies or by modes of thought involving particles possessing energy, momentum, weight, mass, etc., may possibly be beginning at the wrong end; for if it should really be true that electromagnetic properties lie at the foundation of mechanical properties and actions, then it would manifestly be absurd to attempt to use the effect to work backward from the more complex to an explanation of the more simple, or to use the more complex phenomena as a basis for the more simple actions, so to speak.

I was pleased to find last summer that Mr. A. E. Kennelly had about come to the same view.

ELIHU THOMSON.

Lynn, Mass.

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Condensation in Steam Engines.

To the Editor American Electrician:

I have read with interest the editorial in the March number on "Condensation in Steam Engines," and as the subject is one of importance, a further discussion of some of the points involved may not be without value.

The action of the walls of a steam cylinder in producing condensation of steam depends, as pointed out, on their capacity when at a lower temperature, for absorbing heat from the steam, as during admission, and for giving it up when at a higher temperature, as during exhaust. The amount of such prejudicial action depends, therefore, on the range of temperature between admission and exhaust, and on the particular readiness with which as a substance the walls absorb and reject heat, according as they are cooler or hotter than their surroundings.

There are, therefore, two distinct features to be considered—the range of temperature and the characteristic readiness of absorption and emission. Now, it seems to be the case that once the walls of the cylinder become wetted or covered with a film of moisture, the absorption and emission of heat into and from the metal proceed with much greater readiness than when they are dry. In other words, the passage of heat between metal with a moistened surface and moist steam is much more rapid than between the same metal with a dry surface and dry or superheated steam. In the ordinary steam engine we have, therefore, an action of the walls due to the range of temperature employed, and to the natural capacity for cast iron to absorb and emit heat from and to steam, greatly augmented by the presence of a more or less complete film or layer of water over the surface, arising from the condensation of the first entering saturated steam. In the engine using slightly superheated steam we have the same general tendencies as above, but less augmented, because of the smaller amount of moisture formed. In the engine using steam superheated to such a point that the action of the walls and the thermodynamic action serve only to reduce it to near the point of saturation, no moisture is formed, and the action of the walls is limited to that which can take place between their dry surfaces and the dry or superheated steam.

Superheating must not therefore be unstood as effective as against the fundamental action of the walls, for no matter what the working substance, they will still act as a shunt or by-pass to the condenser, or from another point of view, as a place of hiding into which heat can slip and out of which it can escape to the condenser without doing its share of work. The office of superheating is simply to reduce the readiness with which this transfer is carried on, and there is no doubt that such reduction is real and highly beneficial when the superheating is carried to a point sufficient to prevent the formation of moisture in sensible quantity.

Regarding the application of reheaters to the receivers or exhaust spaces of the h.p. or i.p. cylinders, it seems likely, as pointed out, that their beneficial action will be marked in proportion as they are able to superheat the steam passing through them. With saturated or wet steam at the start, however, it is doubtful if they can be depended on to more than dry the steam, and the result would be simply a decrease in the amount of water present in the various cylinders, with probably little added saving in the thermodynamic actions within the cylinders themselves. For best results the steam should therefore be somewhat superheated at the start, and the combination of initial superheater and reheaters may be considered as giving a general superheating effect, broken up into stages, each stage producing sufficient superheating to prevent condensation in the following cylinder.

In considering the question of saving, it must not be forgotten that the net gain from the reheaters consists of the heat saved in the cylinders less that expended in the reheaters, and that in the final balance the latter must not be forgotten as a part of the expense account.

Ithaca, N. Y. W. F. DURAND.

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Electrical Journals.

To the Editor of American Electrician:

As an old telegrapher, I was much interested in the short letter in your March issue from Mr. Edward Caldwell, on early telegraphic periodicals. Fortunately, or unfortunately, in early days while I was with the old American Telegraph Company in its Wall Street headquarters, New York, I had a hobby of collecting all I could on telegraph or kindred electrical subjects, and have to this day preserved much of that period.

As stated, the *Telegrapher* was the pioneer journal in this line, Mr. L. H. Smith, House printing operator, being its first editor. I took a lively interest in it from its inception, contributing many items and securing many subscriptions, though not a member of the Telegraphic Union. I have to-day the original letter from Prof. S. F. B. Morse, who at my solicitation sent his subscription and promised, if a library were started, to add to its archives. The *Telegraphic Journal* was started by a Morse operator, named Jerry Borst. Mr. J. D. Reid seemed to be the editor, and I always suspected that the Western Union Company was behind him, as Jerry, from appearances, inclinations and taste, was about the last man one would expect to go into a literary venture. The death of the Borst paper and the appearance of the *Journal of the Telegraph*, with that most fascinating of writers and gentlest of men, J. D. Reid, as editor, seems to confirm my Western Union theory.

I have copies of nearly every early telegraph or electrical journal, and was the first to issue the *Canadian Electrical News* in this city in 1884—the first paper in Canada devoted exclusively to electrical science but, like many other such ventures, it was ahead of the times and lived but six months. I can supply libraries or collectors with copies.

In those early days I made a collection of original letters and documents on the early history of the electromagnetic telegraph, etc., consisting of a series of letters from those early identified with its development and progress, written in answer to many queries from me, I have arranged the whole loosely in five large quarto volumes, illustrated with some 250 portraits and biographical sketches of all kinds. The letters contain an inside history of this period exceedingly interesting, and from which an interesting volume might be compiled. The letters are from Morse, Gale, Vail, French, Rogers, Wood, Cornell, Pell, Dr. Jackson, House, Hughes, Kendall, Barnes and many others, with portraits of all these people, as well as of Galvani, Volta, Mesmer, Wheatstone, Borelli, Ampere, Ohm and many others. It is such an American history as should a permanent home in the library of some American electrical society, and I might part with it under certain circumstances.

John Horn.

Montreal, Can.

NOTES.

Philadelphia Electrical Exposition.—An electrical exhibition will be held in Philadelphia, beginning June 6 of the present year and continuing one month. The exhibition building is situated on Chestnut Street, between Eighth and Ninth, nearly opposite the Post Office, and extending through to Sansom Street.' Among the features decided upon is an electric fountain, and especial attention will be given to recent electrical inventions and to the exhibits of distinguished inventors. Prof. Wm. D. Marks is director of the Exposition, whose business offices are at 1308 Arch Street.

American Institute of Electrical Engineers.—At a meeting of the Council of the A. I. E. E. on March 23, the following nominees were selected from the proposals submitted by the membership, and will appear on the council ticket that will be sent out previous to the annual election: President, Dr. A. E. Kennelly; vice-presidents, Prof. Robert B. Owens, Mr. William Stanley and Dr. Cary T. Hutchinson; managers, Mr. Herbert Lloyd, Prof. Samuel Sheldon, Prof. George F. Sever and Mr. Charles P. Steinmetz; treasurer, George A. Hamilton; secretary, Ralph W. Pope.

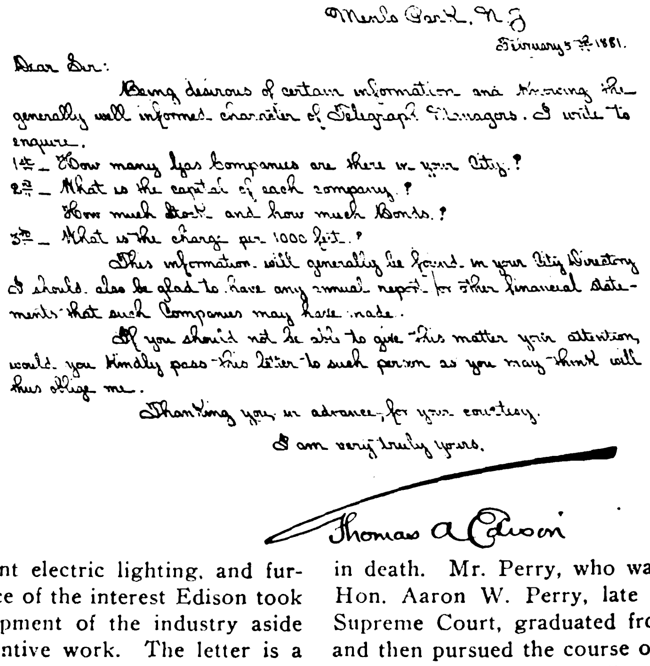
Standard Electrical Diagrams.—A little book containing the report of the Chicago Electrical Association committee on standard diagrams has been issued by that body. This gives the report in concise, convenient pocket-book form for the use of electrical draftsmen and patent attorneys, and for electrical engineers who wish to have a set of the diagrams for reference. To cover the expense of the printing, a nominal price of 10 cents each will be charged. Application for copies should be made to Mr. J. R. Cravath, secretary, Chicago Electrical Association, 825 Monadnock Building, Chicago.

Insulating Compound.—Prof. Fessenden recommends for armature work a compound made by boiling pure linseed oil at about 200 degs. with ½ per cent of borate of manganese, the boiling being continued for several hours, or until the oil begins to thicken. An advantage of this borated oil is that it always retains a slight stickiness, and so gives a good joint when wrapped around wires, etc. Many substances so used are not sticky and let moisture in through the joints. Where a smooth surface is required, it is readily obtained by dusting on a little talc. It can also be given a coat of japan on the outside.

From Over the Sea.—We clip the following kind comment from the editorial page of our London contemporary, *Electricity*: "The fact that we have just received our usual copy of the current number of the *American Electrician* reminds us of the debt which I, in common with so many other of my contemporaries, owe to its pages. One never takes up one of the numbers of this paper without knowing that there is much in it which will be at once interesting and instructive. How the editor manages to secure such practical up-to-date articles is one of those secrets he alone can tell. If any of my readers ever wish to go abroad for scientific information, I could not, if I wished, do better than advise them to subscribe to this monthly periodical."

A Mercury Cutout.—At the March meeting of the Societé Internationale des Electriciens, a new form of switch was described, in which the circuit is opened and closed by mercury. In a box of insulating material are two cavities separated by an insulating partition, the cavities being filled to a certain height with mercury. If a plunger is thrust in each cavity the mercury rises above the top of the partition and closes the circuit; when the plungers are withdrawn, the mercury separates and falls back into the cavities, thus opening the circuit. A number of forms of switches, automatic, cutouts, etc., constructed on this principle, were shown at the meeting, and it was stated that on a circuit of 12 amps. and 3000 volts their use gave excellent results.

A Reminiscence of Pioneer Days.—The accompanying engraving is a reduced facsimile of a letter dating from the early days of incandescent electric lighting, and furnishes evidence of the interest Edison took in the development of the industry aside from his inventive work. The letter is a mimeograph copy, of which the original was written by Edison with his electric pen; the signature is autographic. During the first several years of incandescent electric lighting development, Edison was the guiding spirit in every advance, his inventions being brought forth, not through needs discovered by others, but to perfect a low-tension system of distribution which to-day remains as he completed it. From the above letter it will be seen that his activity also extended beyond the inventive sphere to that of the engineer and the promoter.



Menlo Park, N.J.
February 5th 1881.

Dear Sir:

Being desirous of certain information and knowing the generally well informed character of Telegraph Managers. I write to enquire.

1st_ How many Gas Companies are there in your City?
2nd_ What is the capital of each company?
How much Stock and how much Bonds?
3rd_ What is the charge per 1000 feet?

This information will generally be found in your City Directory I should also be glad to have any annual report or other financial statements that such Companies may have made.

If you should not be able to give this matter your attention would you kindly pass this letter to such person as you may think will thus oblige me.

Thanking you in advance for your courtesy.

I am very truly yours.

Thomas A Edison

Non-Induction of Wire.—The following, signed by Gorham Gray, Boston, appeared in the New York *Herald* as a reply to a letter in a preceding issue, conveying an intimation that the "Maine" disaster might have been due to "induction" from the electric light wires, insulation, it being stated, affording no protection against the danger from "induction": "Noting the remarks of Mr. Miles Pauson in to-day's *Herald*, I beg to say that whether the 'Maine' explosion was from external or from internal contact, it seems to me that no wire insulation can be a safety from induction of current and accidents on land and sea. The wire must and can be self-insulated. No covering can safely avoid accident, although all wire should be in non-contact. As a pipe carries water, so must wire be adjusted to electric current carriage. I believe that our cities and our ships are liable to serious explosions with hardly a knowledge of from what cause, owing to surface electric current wire carriage, and it should be required to be reversed."

Nelson W. Perry.—The death of Mr. Nelson W. Perry, which occurred at Brooklyn, March 27, under distressing circumstances, removed a technical writer who has had few equals as such in this country. While performing some scientific experiments at his house, by mistake he drank from a glass containing poison, and though he subsequently rallied from the effects, a relapse the following day ended in death. Mr. Perry, who was the son of Hon. Aaron W. Perry, late of the Ohio Supreme Court, graduated from Harvard, and then pursued the course of mining engineering at Columbia College. For some time he was professor of chemistry in an Ohio college, and spent a number of years in the mining regions of the West. In

1891 he became editor of *Electricity*, and during part of 1893 was editor of the *Electrical World*; returning to *Electricity* the same year he finally severed his connection with that journal last year. Mr. Perry was one of the few writers on technical subjects possessed of a graceful literary style, which made his writing interesting in reading, no matter how intrinsically dry the subject might be. Always in touch with current scientific developments, his loss as a writer is a most regrettable one, while his wide circle of friends will long mourn his sad taking off in the prime of life.

Another Wizard.—The New York *World*, in its issue of March 20, had a sensational illustrated account of a new electrical invention and inventor, the article carrying the headlines: "Invention's greatest triumph, the making of sunlight," "It gives no heat, is cheaper than gas or electricity, and is so intense and clear that photographs can be taken by its rays," "1,000,000 volts passed through the bodies of four *World* reporters without harming them in the least." A reading of the article discloses that the great invention is vacuum tube lighting, the tubes being of the kind used by Hawksbee in 1709, and the whole exhibition of a kind, though on a larger scale, that could have been gotten up a quarter of a century or more ago in any college laboratory provided with Geissler tubes. Among the demonstrations which startled the reporters was a duplication of Hawksbee's experiment of lighting, by induction, a tube not connected with any wires, and the taking of a photograph "to prove that the light produced was really daylight or a substitute for it"—the reporters probably not being aware that in the photo-engraving department of their own offices, the photographing is done by artificial light. The inventor, John H. J. Haines, we are informed, "has already been hailed by authorities as the probable originator of the light of the twentieth century," and that he has been experimenting with the new light since 1890, five years having been spent on the mathematics and design of his apparatus. The apparatus is stated to consist of two induction coils.

Northwestern Electrical Convention.— For the 1898 summer convention the Northwestern Electrical Association has adopted the plan of engaging the steamer "Northwest," holding short daily sessions on the boat and ending with business and social sessions at Duluth, and a reception and banquet at Superior. The steamer will leave Chicago at noon on Friday, June 10, touching at Milwaukee for delegates who may find it convenient to join the party there, thence proceeding to Mackinac Island for a short stop, enabling a brief inspection of that celebrated resort; thence to Sault Ste. Marie and through the government locks and ship canal; thence to Hancock and Houghton to visit the Calumet and Hecla copper mines; thence past the "Pictured Rocks" and Apostle Islands to Duluth. Two days' stay will be made in Duluth and Superior, then home by rail. The mayors and common councils, the boards of trade and commercial clubs of both cities,have united in a cordial invitation to the association and its guests, and are now preparing for their welcome on arrival, and entertainment during the visit. A "convention hour" each day on the boat will be devoted to discussions by practical men on topics of practical interest to owners and operators of central station plants. It is intended to make the trip a valuable, as well as a delightful, one to all on board. The "Northwest," specially chartered for the occasion, is the largest and finest steamer on the lakes, and is surpassed by no ocean vessel in stanchness and elegance of appointments. She carries a fine orchestra, and has every modern improvement known to passenger boat construction, including an extensive and complete electrical equipment. No one but her officers and crew, and those invited by this association, will be carried on the trip.

Condenser and Induction Coil Insulation.— In making condensers, Prof. Fessenden advises, in a recent Institute paper, that the paraffine be heated at 220 degs. F., about three hours. The paper should also be heated and plunged into the hot paraffine. When made up, the condenser should be boiled for several hours to remove the air. A condenser so made, he says, if perfectly pure cellulose is used (perfectly pure paper is used in practice), and with pure paraffine, will stand 250 volts per thousandth of an inch when the dielectric is less than .01 in., and at a higher rate for greater thicknesses, with which the effect of small defects in one sheet of paper is not so serious. Practically the same remarks apply to the making of induction coils. Here, however, the great difficulty is that the paraffine in cooling is sure to shrink, and will leave hollows inside. The way to get over this is to construct the coil so that when cooling the shrinkage will take place outside, just as if one were making a casting of some metal having great contraction. The coefficient of adhesion also should be less between the walls of the mold and paraffine, than between the wire and paraffine; also the outside should never be let harden first, as then, of course, a hollow space is left inside. Another precaution is to expel all gases by heating the paraffine for some time above the temperature at which the coils are to be boiled. The coils should be boiled above 212 degs. F. for some hours to drive off the loosely combined water. This destroys the mechanical strength of the cellulose, but as the whole coil forms a solid mass this is of no great consequence. Silk should never be used where high insulation is required, as pure cellulose dry and boiled in paraffine is so much superior to it that there is no comparison. With pure cellulose, coils with only 1700 ft. of wire per inch of spark stand perfectly; that is, the spark may be five times longer than the coil. In ordinary use, coils having a spark length 3 1-3 times that of the coil have been run for long periods with no break-downs. Gilsonite mixed with paraffine is recommended as a good insulation for induction coils. The same material in combination with linseed oil also makes a good insulation.

Electrical Exhibition. —An interesting feature of the Electrical Exhibition to be held at the New York Madison Square Garden, during the month of May, will be a telegraphic tournament, which will include a typewriter receiving contest. Mr. Fred. Catlin, the manager of the tournament, hopes to make some new records for speed, both in sending and receiving. One of the remarkable features of the show will be an exhibition by Mr. H. V Pearsell, the well-known New York banker, of a collection of galvanoplastic objects, including reproductions of celebrated works of art, replicas of medals, antique coins, etc. Among the curious items are casts of living snakes and frogs, which are prepared as follows: A snake, for example, is etherized under a bell jar, then placed on a glass plate and posed. Around him is built an enclosure of four square bars, and a thin plaster slowly poured over the snake, the bars confining the cast in a rectangular shape. When the plaster is hard, it is freed from the sticks and glass plate, and the now defunct reptile is carefully removed, tail first from the cast. The plaster cast thus obtained is rendered waterproof by immersion in melted paraffin. A metallic conducting surface is then given to the interior of the cast by moistening the surface of the mold with a solution of silver nitrate and by exposure to sulphuretted hydrogen, which precipitates the silver on the cast. A conducting wire is now fastened around the edge, and the mold is carefully suspended in the depositing bath. A good firm coating takes about three days to form, and then the mold is softened in boiling water, and carefully broken off. Among other curious exhibits, will be the remains of two eagles, some storks and other birds, which had short-circuited high-tension circuits in California, while sitting on the wires, with the result of leaving only their beaks and talons, not a vestige of the bodies or feathers being discovered. Col. Heft, of the N. Y., N. H., & H R. R., has furnished drawings of the three-rail system used on his road, from which a model exhibit is being made. Over a track in the hall a train of cars will run to and fro continually, showing how the current is picked up and delivered to the motor, and how the switches and signals are included in the operation. A committee, which includes Profs. Geyer, Doremus and Loeb, has drawn up rules and regulations for an amateur electrical model-making competition, including small dynamos and motors, galvanometers and other measuring instruments, ingenious applications of electrical apparatus to electrical uses, etc. There will be included a competition of designs and working drawings of electrical apparatus by students and teachers.

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Condensation in Steam Engines.

In another column Prof. W. F. Durand gives an admirable résumé relating to the action of the walls of a steam cylinder in producing condensation of steam, and the function of superheated steam in preventing such condensation. As pointed out, there are two factors entering in the general case—the range of working temperature and the conditions of the walls of a cylinder with respect to readiness of absorption and emission of heat. If the walls are wet or damp, they serve as a hiding place for heat, which is absorbed at admission and passes into the condenser after release without doing useful work.

The function of superheated steam is thus evident, being to keep the cylinder walls dry and thus reduce to a minimum their prejudicial effect. As this applies to each cylinder, it follows that for the best results the steam should be initially heated. Indeed, Prof. Durand is of the opinion that if the steam is wet at the start, it is doubtful if there will be any considerable saving from the use of receiver reheaters. It may be added that Corliss early recognized the value of initial superheating, and used a type of boiler in which the amount of this could be controlled within limits by having a greater or less amount of vertical tube surface above the water line.

Among Our Foreign Contemporaries.

With this issue we commence a new department under the above caption which, we believe, will be of much benefit to our readers. It will consist of notes and abstracts from our foreign contemporaries, the matter being confined to subjects of live interest or of direct practical value. Reference will not necessarily be made to the entire scope of the original article, the object being to give in a note the meat of an article, or to extract from it such part or parts as contain information of direct value, irrespective of the object of the writer in including such information. Where thought desirable, comment will be added, or the information extended. In short, the intention is not to give an index to foreign literature, but to select from it only such parts as may be considered of direct value to American readers, and to present it in a form that will make each note complete in itself. Should it happen, however, that a reader wishes to refer to the original article, we shall be glad to supply the indications necessary for him to obtain the number of the journal in which it appeared. The fact that Mr. Charles T. Child will have charge of this department will, we believe, be accepted as an assurance that its value to the reader will be of the highest. We will add that the matter will be compiled from the principal English, French, German, Italian and Spanish electrial and other technical journals, thus keeping our readers in step with electrotechnical progress in practically the entire world.

Fan Motors.

On other pages will be found our annual article on new models of fan motors, containing illustrations of the principal types that are now being placed on the market for the coming season. That there are improvements in efficiency over last year's models can safely be assumed in view of the competition in the field, and the growing use being made of the ammeter—either by the purchaser or the salesman who desires to demonstrate the superior efficiency of his motor. As to mechanical efficiency, no assumption is necessary, the introduction of ball bearings and bicycle fitting vouching for this. In shape and finish there has also been an advance, the machines of the present day being a vast improvement in this respect over those of even a few years ago.

One of the most interesting electrical machines of the day from the technical standpoint is the alternating current fan motor. When first put on the market this consisted of a series wound machine with a commutator. As the polarity of the armature changes with the polarity of the field as the current changes sign, its action was the same as a direct-current motor, except that the turning torque pulsated from a zero to a maximum value each alternation. The present alternating current motor is of the rotary field type; the field, however, not having the constant value of a regular two or three phased motor. The Shallenberger alternating current meter very clearly illustrates the mode of action of the present induction fan motor. The primary coil of the meter induces in a closed coil a secondary current differing in phase, the result being a rotary field which sets in motion a closed ring in the field. Similarly, in an induction fan motor some of the field projections are provided with a closed coil in which a neighboring primary sets up an induced current; the reaction of these poles with the primary poles sets up a rotary field which acts on a closed-circuited armature. If desired, an arrangement may be added to cut out the induced field when the machine gets up to speed, the motor then running as a synchronous single alternating current motor.

What Is Electricity?

In another column will be found a number of comments from authoritative pens, on an article which appeared in the March issue giving a résumé of the present state of knowledge concerning electricity. As the views expressed in the article, while contrary to popular opinion, yet merely expressed the scientific thought of the day, they are, as might have been expected, not controverted in any essential point. Dr. Kennelly brings forth an interesting speculation, but one which seems to be based upon the definition of the word "entity" rather than offering any conflict with present views. The remarks of Dr. Macfarlane on the two ways in which physical phenomena are regarded are suggestive, for it is by a lack of proper distinction between the objective and subjective, or through confounding the two, that the popular misconception concerning electricity has arisen. The views of Prof. Thomson on the relations between the various forces are extremely interesting, as they express the belief that the mechanical forces and properties, as well as chemical attraction, are dependent upon the electromagnetic properties of ether, and that the latter may furnish the key to the elucidation of the so-called molecular sciences.

The answer to the question, What is electricity? is then, that as electricity is but a name, there can be no answer. The true form of the question, and one that may some day meet with an answer is, What is the mechanism whereby mechanical, thermal or chemical energy is transformed into electrical energy? But even should a complete answer be given to the latter question, we know that it would not result in decreasing the cost of any of the present commercial methods of generating electrical energy, for the reason that the present transformations are so nearly perfect as to leave no margin. For example, in the article on another page on the Dolgeville plant, it is stated that the electrical generators are guaranteed to work at an efficiency of 94 per cent—that is, to turn into electrical energy in the exterior circuit 94 per cent of the mechanical energy supplied to the armature shaft. In the 6 per cent loss are included the bearing, air and collector brush friction losses; the electrical energy turned into heat in the windings and connections—that is, the copper losses; the energy lost in eddy currents and in hysteresis, that is, the iron losses. Which of these losses could be reduced by a complete knowledge of electrical action, and would their amount warrant, from the commercial standpoint, any expenditure of thought to attain such knowledge?

Should one be pressed for a reply to the question, What is electricity? he could retort by asking, What is gravitation or heat or light? If informed that "Electricity is but in its infancy," he might ask his informant in turn if he believed that gravitation, heat or light are also only in their infancy. If met with the prophecy that when we know more of electricity there will be marvelous developments in that branch, it would be well to ask if were we to know more of gravitation, should we also expect marvelous improvements in pile drivers and other mechanical machines. In short, let it be understood that instead of electricity being particularly surrounded with mystery, as much is known concerning it as is known of heat and light, and more than is known of gravitation.

Apparent Increase of Resistance of Conductors.

When an alternating current passes through a conductor there is an apparent increase of resistance of the conductor due to causes that will be noted further on. The drop which results from this increase of resistance should not, however, be confounded with the inductive drop due to the passage of an alternating current in a circuit. In the former case, with ordinary sized conductors and commercial frequencies, the increase of drop is negligible while in the latter case this is, of course, not true. The causes are different, inductive drop being due to the cutting of lines of force in and out of the area inclosed by a circuit, while the apparent increase of resistance in the conductor is due to the current being crowded toward the circumference, which is equivalent to the cross section of the conductor being lessened.

We can imagine the current flowing through a conductor to consist of an infinite number of filamentary currents, or the conductor to be composed of an infinite number of filamentary conductors, each carrying a current. If alternating, each of these currents will exert an inductive action on all of the others and in turn will be similarly influenced by them. Thus, filamentary conductors which lie nearest to the axis of the conductor will, it can readily be seen, be subjected to greater inductive action than a filamentary conductor lying on the circumference. The consequence is that the inductive or counter e.m.f. thus set up and opposing the flow of current, will be strongest at the axis of the conductor and weakest at the periphery. In other words, there will be greater opposition to the flow of current along the axis, and consequently the flow will be least there, increasing toward the circumference. The effect of this is as if the specific resistance of the conductor were increased by the passage of an alternating current, but we see that the real explanation is that all of the cross section of the conductor is not equally employed in transmitting the current. In the extreme case, where the frequency is enormous, but little current passes through the central portion of the conductor, it being practically dead.

With commercial frequencies, the phenomenon described need not be considered except in the case of very large conductors. For example, with a frequency of 80 the apparent resistance of a 000 conductor is only increased one-hundredth of 1 per cent. With a conductor 2 ins. in diameter, however, the resistance opposed to the passage of an alternating current with a frequency of 80, is twice as great as with a direct current. When it is necessary to use conductors of very large area, as on switchboards where a very large quantity of power is handled, hollow conductors should be used, for the reason that where the cross section is annular, the effect which we have described is very much lessened, since the filamentary currents are at a very much greater mean distance from each other. It is sometimes said that this is equivalent to removing useless copper at the core of a solid conductor and adding it to the periphery, where it will be utilized.

A lightning discharge is oscillatory in character, the thunderbolt thus being comparable to an alternating current of very great frequency; consequently, the resistance offered to a lightning discharge by the best conductor is enormous, since the current only travels along the skin. In this connection, it is interesting to note the different views that have been held concerning lightning conductors from the earliest days. Franklin believed in the use of solid lightning conductors, not knowing, of course, the effect of the frequency on confining the lightning discharge to the skin. About thirty or forty years ago lightning conductors began to be made of sheets of metal, generally twisted in spirals, on the absurd theory that since electricity resides on the surface, the surface of a conductor should be made very large. Later, when some scientific thought began to be given to lightning conduction, a return was made to the solid cross section. About fifteen years ago Prof. Hughes read his memorable paper on the conduction of currents of high frequency, in which experiments were described that definitely proved that the density of such currents is not uniform throughout the cross section, being greatest near the periphery. The theory applying was shortly after worked out, and several years later Lord Kelvin, then Sir William Thomson, published the formulas now in use for calculating the apparent increase of resistance of a conductor with frequency.

A LECTURE ROOM GALVANOMETER.

BY PROF. R. W. QUICK.

In giving experimental lectures in electricity before large classes of students, some type of galvanometer is necessary whereby the deflections of the needle can be plainly indicated to the whole class. This is sometimes accomplished by means of a long pointer attached to the needle, whose actual motion is thus directly observed. On account of the non-sensitiveness of such an instrument, deflections at times are too small to be observed, thus very much limiting its usefulness. Recourse is then had to a sensitive galvanometer of the mirror type and fibre suspension—the deflections being indicated by the movement of a spot of light obtained by the reflection from the mirror of a beam of light from a lantern.

Such a galvanometer fulfills all the requirements of sensitiveness, and gives observable deflections, but has one inherent defect which militates almost entirely against its use in many lecture rooms. Many lecturers have at their disposal only one stereopticon, which is ordinarily used to project on the screen apparatus in an experiment or to exhibit lantern slides. To use this with a mirror galvanometer would necessitate a change of position of the lantern and the consumption of much valuable time if it had to be done, as is so often the case, in the course of a lecture.

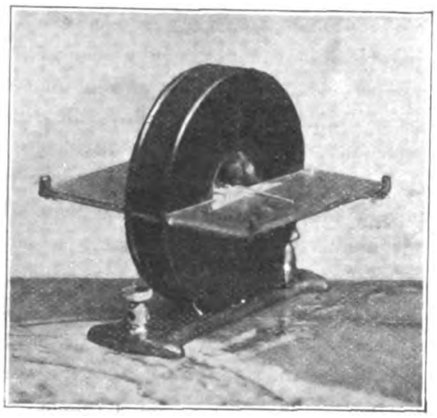
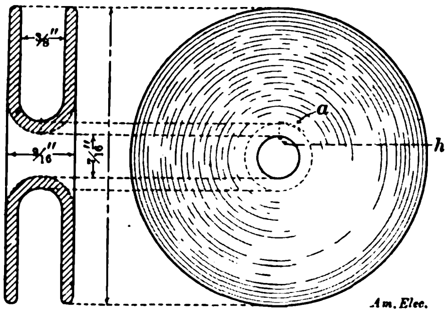


FIG. 1.—LECTURE ROOM GALVANOMETER.

Two years ago the writer designed and constructed an instrument with a view to eliminating the objectionable features of the mirror galvanometer, and at the same time preserving its many good qualities. The characteristics of this galvanometer may be summed up as follows: Its needle deflections are plainly indicated; it is extremely sensitive; it shows quantitative relations of current throughout the whole range of its deflections; and it requires no adjustments in setting up except to turn the focus screw of the objective of the lantern. It only requires a vertical attachment to the lantern, an accessory which can scarcely be dispensed with in the use of a lantern for the projection of physical phenomena.

Having subjected this galvanometer to a thorough test extending over two seasons, and consequently believing that, on account of its simplicity of construction and ready adaptability to any lecture room provided with a lantern and its accessories, it would fill a want, a brief description is here given, accompanied by dimensioned sketches and a photograph of the instrument now in use in the writer's lecture room.

Referring to Fig. 1 the instrument is seen to consist of a hard-wood spool containing the copper wire, arranged in a vertical plane on a narrow wood base, shown separately in Fig. 4. At the centre of the hole through the spool, whose elevations are shown in Figs. 2 and 3, is suspended by means of a single silk fibre, an aluminum pointer, visible in Fig. 1, whose length is 1¾ ins. and whose width at the centre is 1-16 in. On the under side of this pointer, at its centre, and at right angles to its length, is fastened by aid of wax a watch spring magnet a little less than 1-16 in. long. Underneath the pointer, with space for clearance, is placed on each side of the spool a glass shelf containing a scale with divisions proportional to the tangents.



FIGS. 2 AND 3.—END AND SIDE ELEVATIONS.

Placing the instrument on the vertical attachment of the lantern, the light is reflected upward through the glass shelf, after another reflection is rendered horizontal, and the image of pointer and scale is focused on the screen or wall.

With a magnetic needle of the above length and with dimensions of spool as given in Figs. 2 and 3, the galvanometer obeys almost exactly the tangent law, and hence is extremely useful for quantitative experiments. In order to allow a sufficient deflection of the pointer, the hole in the spool should be shaped as shown in Fig. 2.

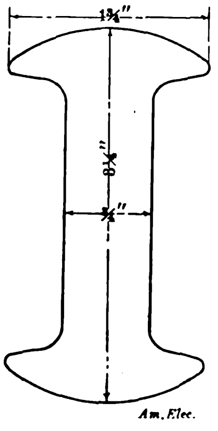


FIG. 4.—BASE.

The glass shelves can be held in place by various methods. A simple way is to pass stiff copper or brass rods or wires through holes near the periphery of the spool flanges, as can be seen in Fig. 1. On these supports the glass shelves are fastened. By far the best method to provide the glass with a scale is to immerse for several minutes a non-exposed photograph plate into the hypo solution, which leaves the film perfectly transparent. After drying, the glass plates, which have been previously cut to proper sizes (2½ ins. x ⅞ in. for the galvanometer shown in the photograph), are firmly secured, film side up, on a table at exactly the distance apart which they will be when fixed on the spool, and by means of drawing instruments and india ink, a circular scale, with divisions proportional to the tangents, can be very accurately drawn on them. The numbering of the divisions should be such as to make the figures in their proper positions on the projected image when the plane of the coil is in the magnetic meridian.

Whatever form the base of the instrument is made to assume, it must allow the free passage of light vertically through the glass scale. The thickness of the one shown in Fig. 4 is 5-32 in. To provide a means of support to the suspended system, a very small copper wire terminating in a small hook, *h*, Fig. 3, is inserted through the spool before it is wound, with its inside end, *a*, turned down and held firmly by the copper wire that is afterward wound on the spool. With considerable dexterity and more of patience, a silk fibre, already attached to the aluminum pointer with its magnet, can be fastened by wax to the hook, *h*, so that the pointer, when properly balanced, will nicely clear the glass shelves.

The size of wire on the spool depends entirely upon whether the galvanometer is to be used with high resistance or low resistance circuits. No single galvanometer can be entirely satisfactory for *all* classes of lecture experiments; for example, in thermal currents a very low resistance galvanometer should be used, while a high resistance instrument is generally desirable in showing induced e.m.fs. A resistance of about 5 ohms, given by No. 24 B. & S. wire on the spool of Figs. 2 and 3, is satisfactory for most experiments.

To minimize the disturbing effects of air currents on the pointer, a paper is cut of proper shape to be inserted just beneath the pointer, and is stuck with mucilage to the under side of the inside edges of the glass shelves, as shown in Fig. 1. The galvanometer should also be provided with a cylindrical case having a glass plate top that can be placed over the instrument when in use in the lantern.

A 5 ohm galvanometer constructed with above dimensions, in the earth's field as controlling force, will give an observable deflection on the screen, when joined in series with a storage cell and 1000 ohms resistance.

Georgia School of Technology, Atlanta, Ga.

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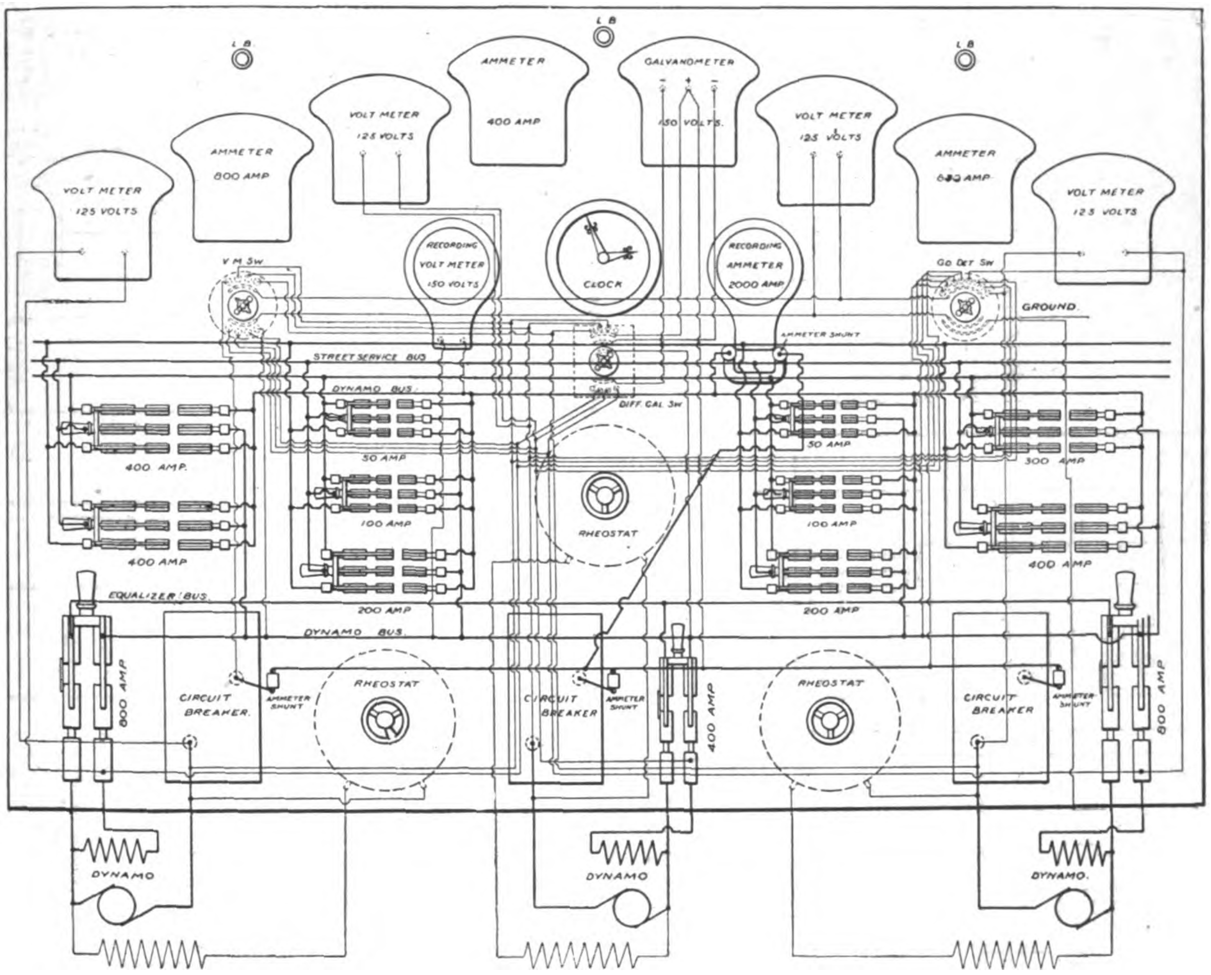
Water as a Non-Conductor.

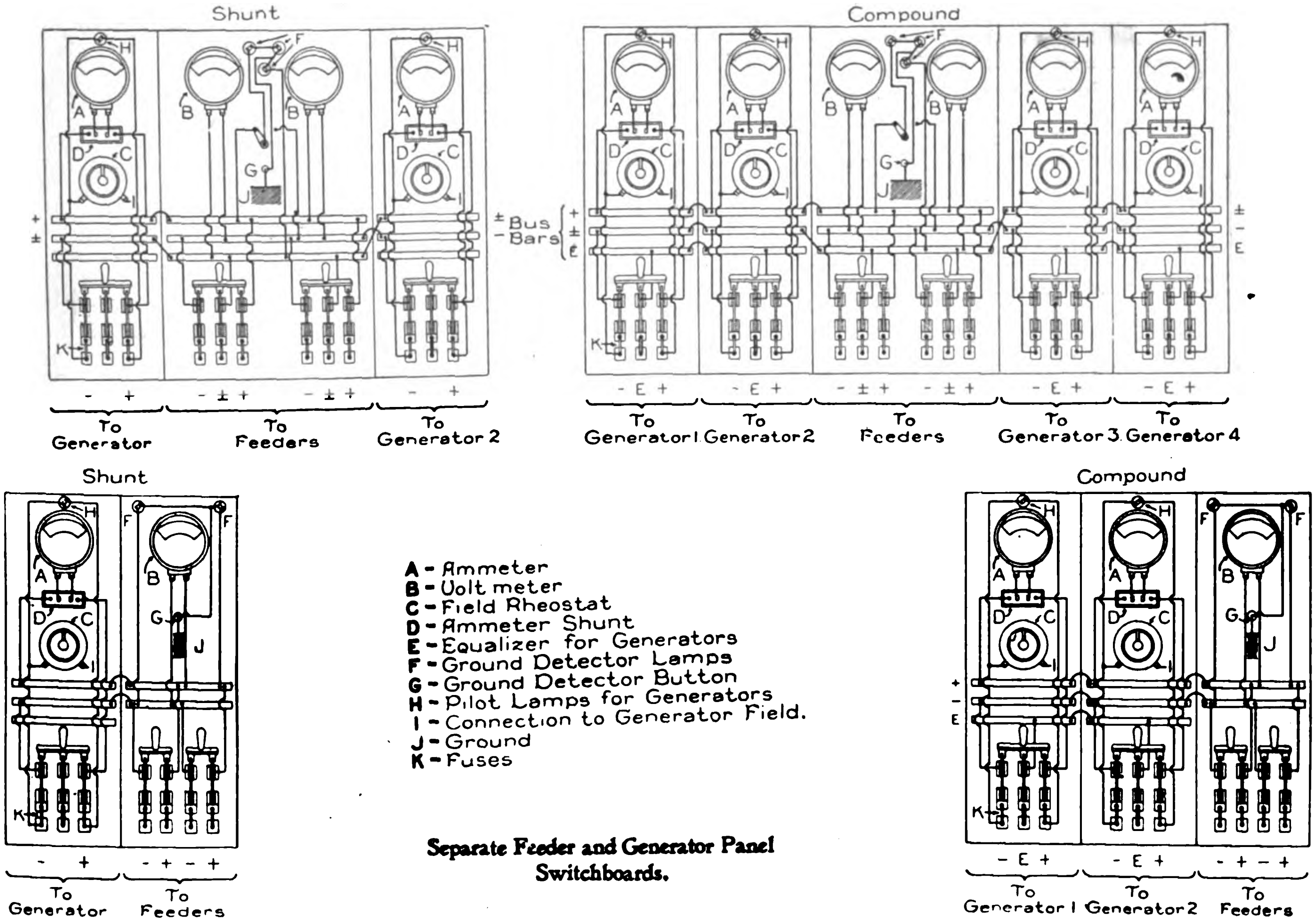
Perfectly pure water is a non-conductor of electricity, but being an almost universal solvent, it is not found pure in nature, and when prepared by distillation soon becomes contaminated. The evil electrical effects of dampness and wet are, therefore, due to the matter dissolved in the water present.

LIBRARY

ISOLATED PLANT DIRECT CURRENT SWITCHBOARDS.


L.B.
L B
L B
VOLT METER 125 VOLTS
AMMETER 800 AMP
VOLT METER 125 VOLTS
AMMETER 400 AMP
GALVANOMETER 150 VOLTS
VOLT METER 125 VOLTS
AMMETER
VOLT METER 125 VOLTS
RECORDING VOLT METER 150 VOLTS
CLOCK
RECORDING AMMETER 2000 AMP
V.M. SW.
GD DET SW
GROUND
AMMETER SHUNT
STREET SERVICE BUS
DYNAMO BUS
DIFF. GAL. SW
400 AMP.
400 AMP
50 AMP
100 AMP
200 AMP
50 AMP
100 AMP
200 AMP
300 AMP
400 AMP
RHEOSTAT
EQUALIZER BUS
DYNAMO BUS
800 AMP
CIRCUIT BREAKER
AMMETER SHUNT
RHEOSTAT
CIRCUIT BREAKER
AMMETER SHUNT
400 AMP
RHEOSTAT
CIRCUIT BREAKER
AMMETER SHUNT
800 AMP
DYNAMO
DYNAMO
DYNAMO

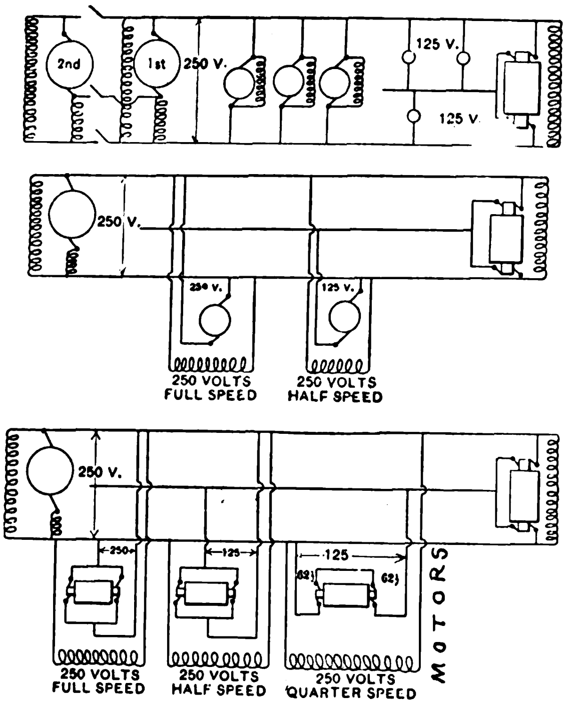
Office Building Switchboard with Street Connection.


Shunt
Compound
H
F
A
B
C
D
G
I
J
K
+
±
± Bus
– Bars
+
±
E
- +
- ± +
- ± +
- +
- E +
- E +
- ± +
- ± +
- E +
- E +
To Generator
To Feeders
To Generator 2
To Generator 1
To Generator 2
To Feeders
To Generator 3
To Generator 4
Shunt
Compound
- +
- + - +
- E +
- E +
- + - +
To Generator
To Feeders
To Generator 1
To Generator 2
To Feeders

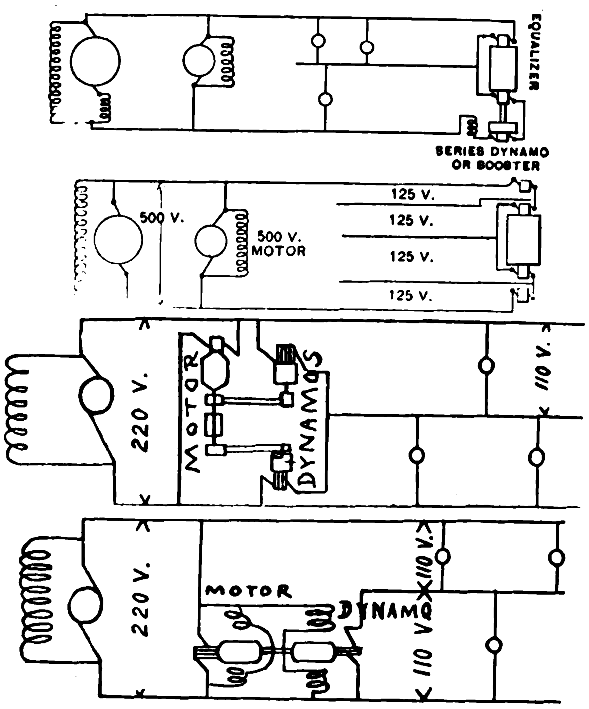
A - Ammeter
B - Volt meter
C - Field Rheostat
D - Ammeter Shunt
E - Equalizer for Generators
F - Ground Detector Lamps
G - Ground Detector Button
H - Pilot Lamps for Generators
I - Connection to Generator Field.
J - Ground
K - Fuses

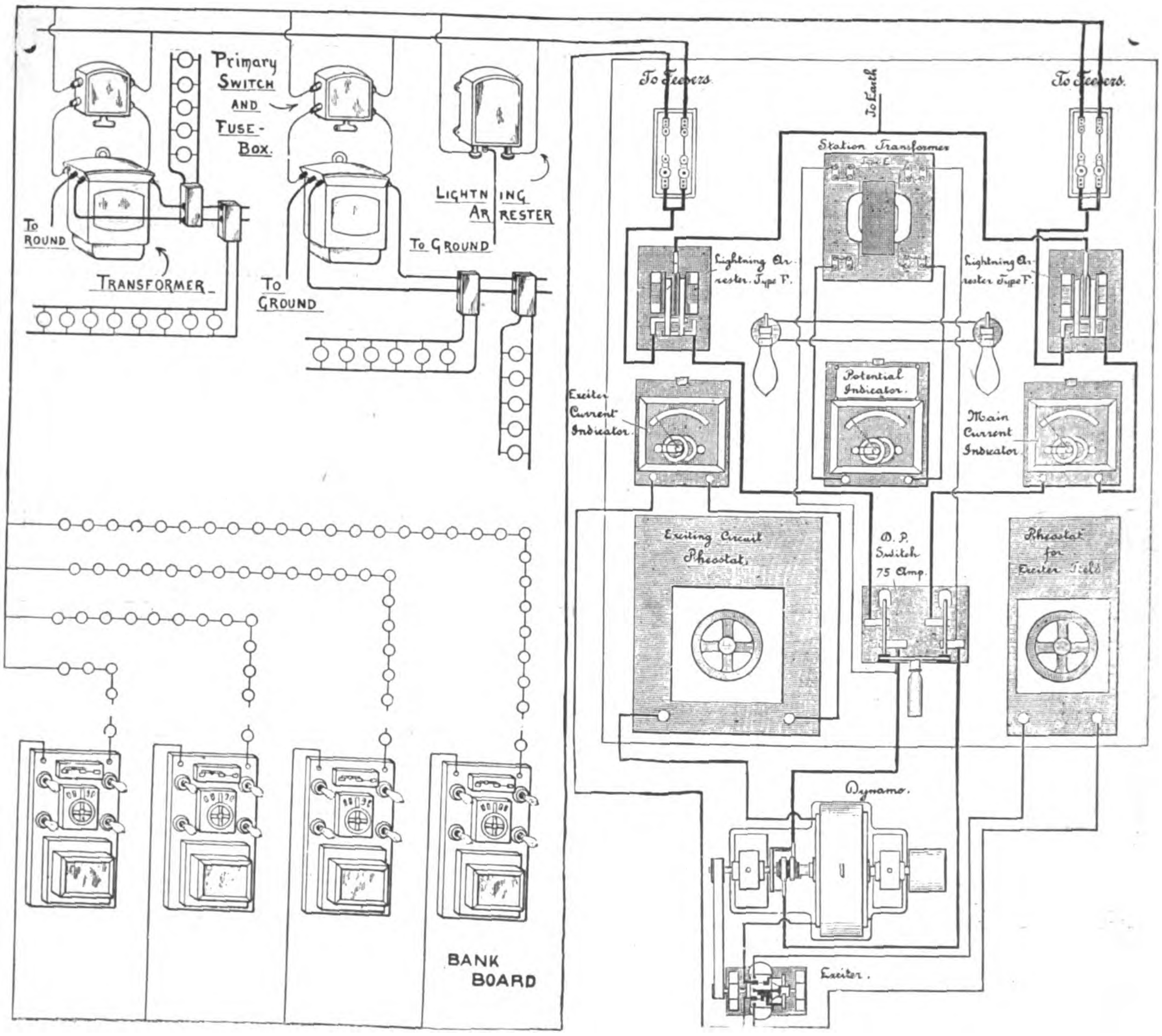
Separate Feeder and Generator Panel Switchboards.

DISTRIBUTION.


2nd
1st
250 V.
125 V.
125 V.
250 V.
250 V.
125 V.
250 VOLTS FULL SPEED
250 VOLTS HALF SPEED
250 V.
250
125
125
62½
62½
MOTORS
250 VOLTS FULL SPEED
250 VOLTS HALF SPEED
250 VOLTS QUARTER SPEED

Equalizer Systems.


EQUALIZER
SERIES DYNAMO OR BOOSTER
500 V.
500 V. MOTOR
125 V.
125 V.
125 V.
125 V.
220 V.
MOTOR
DYNAMOS
110 V.
220 V.
MOTOR
DYNAMO
110 V.
110 V.


Primary Switch and Fuse-Box
To Round
Transformer
To Ground
Lightning Arrester
To Ground
To Feeders
To Feeders
To Earth
Station Transformer
Lightning Arrester Type F
Lightning Arrester Type F
Exciter Current Indicator
Potential Indicator
Main Current Indicator
Exciting Circuit Rheostat
D. P. Switch 75 Amp.
Rheostat for Exciter Field
Dynamo
Exciter
BANK BOARD

Single Phase Alternating, Series and Parallel.

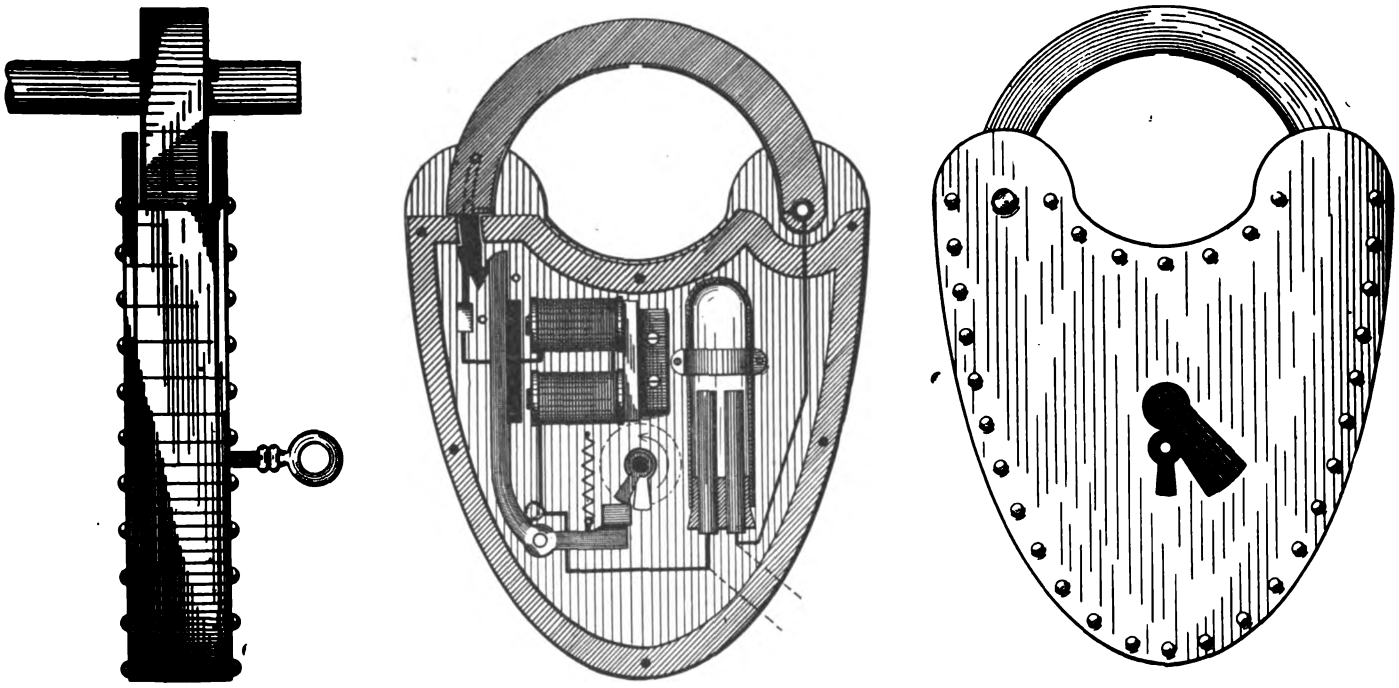
ELECTRICAL APPARATUS FOR AMUSEMENT—IV.

THE OBEDIENT PADLOCK.

BY NEVIL MONROE HOPKINS.

Had the cell doors of the Bastile, or the gates of detention in the fortress San Leon, been equipped with such accommodating mechanism, friendly to those of the Black Art, as the herein described magic lock, the notorious Count Cagliostro would have fared less badly because of his illegitimate use of sleight of hand, together with his fraudulent practice of medicine and association with freemasonry. Although this celebrated trickster caused the bolts in the Bastile to be thrown, regaining his liberty to again practice theft, and impose on the ignorant with his "elixir of immortal youth," the locks of the fortress San Leon were turned upon him with less mercy, imprisoning him until his death in 1795. As the space in the following columns is devoted to a constructive description of a specific piece of mechanism and its accessories, the writer can only refer those interested in this famous quack to the miscellaneous essays of Carlyle, where an absorbing picture of him is painted.

By referring to the first illustration in the series, the "portrait" of the lock may be seen, its true "character" not being learnable from its face. In addition to familiarity with the physiognomy of the lock, one may become intimate through handling, unlocking, and locking by means of its key, without the slightest chance of the lock's real character being understood. Unfortunately for those who practice sleight of hand on the streets of our modern cities, the lock herein represented is the only one in existence, although the following description may lead to the completion of others for the liberation of ghosts and phantoms. The second illustration shows up the internal mechanism of the lock from behind, the back plate being removed.



FIGS 1, 2 AND 3.—FRONT, INTERIOR AND SIDE VIEW OF PADLOCK.

This lock should be made at least 8½ ins. in height, measuring from the bottom, to the top of the hinged staple, and 6 ins. in extreme width. The lock is best made from hard, well seasoned wood, and is put together with furniture glue in combination with brads, or round headed screws. In starting the construction of this padlock, a satisfactory design is drawn full size by means of French curves, and compasses on a smooth piece of board 1 in. thick. If the lock is to be painted, black walnut will answer admirably, the thin covers for the front and back being readily obtained in this wood. Having completed a full size drawing of the lock on the 1 in. board, the design is cut out by means of a band saw, the use of which may be had in almost any patternmaker's shop or saw mill. This may of course be done by hand, employing a fine tapering saw blade used in sawing out circles, but the resultant model is liable to be less accurate.

Having this accomplished, the center must be sawed out, leaving a wall at least ⅜ in. thick all around. Where the staple of the lock hinges, the wall must have an inward curve, as illustrated in Fig. 2, the wall being drawn in with cross sectional lines. Two additional pieces of wood must be sawed accurately to pattern, from wood ⅛ in. in thickness, which form the front and back covers of the lock, by gluing and screwing respectively to the thick pattern or frame. The front plate is securely glued, and screwed to the front of the frame, using some 30 round headed brads or screws for effect. In order to prevent the splitting of this frame by the screws, small gimlet holes must be carefully made for their reception.

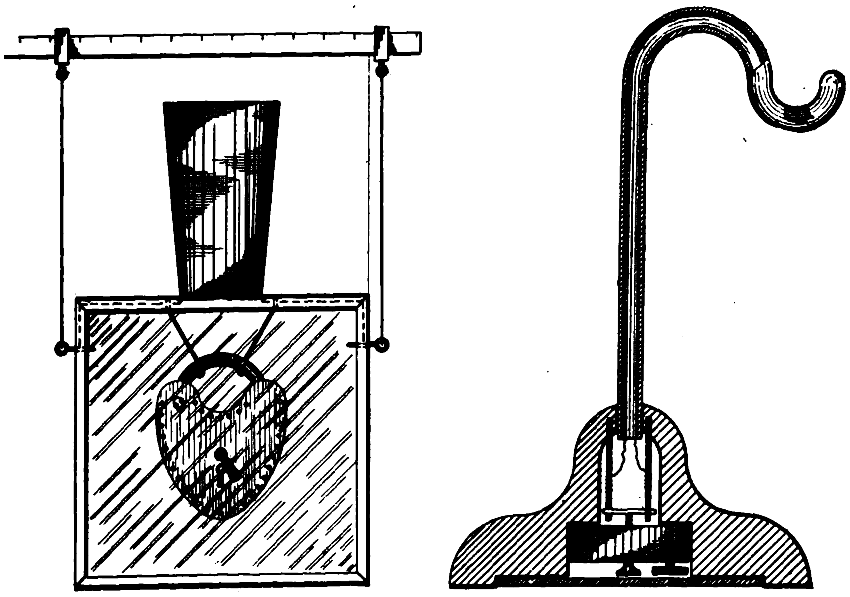
The hinged finger, or staple, is sawed from a piece of the 1 in. board, being a perfect semi-circle ⅝ in. in depth, by the 1 in. in thickness. A thin brass catch is filed to shape, and attached to the free swinging end of the hinged staple as shown. This catch may be made slim and broad, extending across the width of the lock, or it may be a little over ¼ of an inch square, with a 1 in. shank running into a hole in the staple. If a square catch is made, the wall of the framing should have a neat square hole cut out to allow the easy entrance of the catch into the lock. In order to make the connection between the shank of the catch and the swinging staple secure, both should be drilled through, and be provided with little hard wood plugs driven in. The catching mechanism on the inside is very simple, designed to be tripped, or thrown by means of a key, as shown, or by means of the pair of electromagnets. This catch may be made entirely from iron, or be cut from brass, and be equipped with an iron armature opposite the magnet poles.

As the front of the lock is only a thin wooden cover, the magnets and the pivot cannot be made very secure by screwing directly to the wood, the use of a thin brass plate being recommended. This brass plate, not shown in the drawing, can to advantage be made to cover the key hole, being drilled out to just admit the key. In order to prevent the key from wabbling in the lock, the back plate before screwing on should be provided with a pin, fitting into the hollow of a chosen key. A spiral spring keeps the catch away from the magnet poles, and in contact with the locking catch.

It will now be seen that the lock is closed and opened exactly like an ordinary spring lock, having a secret pair of electromagnets in addition capable of releasing the catch with the key absent. This lock being self-contained, carries its own battery for the operation of the magnets. Before describing the type of battery the operation of the lock will be explained.

It will be observed that the brass catch on entering the lock makes contact with a spring jack or electrical contact strip of brass. This spring jack leads to the electromagnets, and thence to the pole of the little battery. The other pole of the battery is connected to the pivot of the swinging staple. This pivot is of brass mounted on a little brass plate for strength, and is screwed to the wooden sides of the lock. Two thin strips of brass or copper are bent around under the staple, and are attached by the smallest brads. As illustrated these will now be readily seen that any metallic body coming in contact with the two brass strips do not meet in the center, a gap of about ⅛ in. being left. One of these strips is secretly attached to the pivot of the staple, and the other to the brass catch. It strips will complete the electrical connections and throw the catch of the lock.

The battery in the present case consists of a large glass test tube or combustion tube, as used in chemical laboratories, fitted with a rubber stopper with two holes. These may be had from any chemical supply house, the combustion tubes being preferable because of thicker glass. The elements of the battery consist simply of a carbon, and zinc stick. As shown, the battery is seemingly installed upside down, but this was intentionally done in order to put the battery out of use when not needed, thus saving the zinc, by turning the lock bottom side up, causing the exciting fluid tery is seemingly installed upside down, but this was intentionally done in order to put the battery out of use when not needed, to occupy the free end of the tube. The exciting fluid may be either a solution of bisulphate of mercury, or of bichromate of potash and dilute sulphuric acid. To excite the battery with bisulphate of mercury, about half a teaspoonful of the powder is put in the test tube or combustion tube, and sufficient water added to allow of the covering of the elements when the battery is in use. To charge the combustion tube with the bichromate of potash and acid, an ounce of sulphric acid should be added to three ounces of water, and a lump of bichromate of potash added the size of a walnut. With this solution the zinc of the battery shoud be amalgamated with metallic mercury. This is quickly done by dipping the zinc in the acid solution for a few seconds, then removing and rubbing with mercury until the zinc shines like a mirror.



FIGS. 4 AND 5.—METHODS OF EXHIBITING TRICK.

The magnets should be wound with comparatively fine wire in order to secure good excitation with a single battery with such small elements. For best results, the resistance of the magnet should equal that of the battery. Of course, if two such cells are added the lock will open with more energy. It will also be apparent that the lock may be worked from an outside battery, whose wires are secretly brought in contact with the copper bands under the staple, if the two wires where they enter the little contained battery are twisted together. These wires are marked with dotted lines, showing how easily the battery may be "shunted out." The back plate of the lock may now be screwed on, and the lock carefully sandpapered in order to make all edges neat looking and even. The back of the lock should have the same number of screw heads showing as the front, for the sake of appearance, but only six of these need be real screws in order that the back may be easily removed. Some little skill and care is necessary in the succesful making of this lock, as it should present only the neatest and most innocent appearance.

Having charged the battery, and screwed on the back, the lock is ready for a test. Fig. 3 shows a method of exhibiting the "wonders of its intelligence." In this case the lock is represented hanging from the end of the magician's wand. The wand has a little metallic saddle of copper or brass attached near one end which may be brought in contact with the bands under the staple of the lock by secretly turning the wand. The conjurer may hang the lock from one finger, allowing the double bands to come in contact with his ring when the lock is commanded to open. Figs. 4 and 5 show two additional methods of showing the trick. Fig. 4 represents the lock hanging from a couple of hooked wires on the inside of a glass box. The box has thin wooden framing and glass sides like a honey box. The screw eyes are for effect, made to pass right through the sides of the framing. The top of the box is provided with little copper plates connected with the supporting hooks, which may be joined by standing any metallic body upon them. In the present case a little tin cup without any bottom is represented standing on the plates. The bottom edges of this cup have been shellaced, making the device inoperative unless the key, or a coin is thrown in.

Fig. 5 shows a design for an automatic device with which the lock may be opened without the assistance of the operator. This little stand may be placed on a piece of glass and covered with a glass shade, and yet the lock will be opened at the command of the magician. This stand has at the hook a couple of small insulated saddles, with connecting wires running to the base. Here a cheap watch movement is provided capable of connecting the circuit at almost any determined time. The performer must know when to expect the watch to make contact, by experimentation after it is once released, or he may say the watch will open when a dispatched spirit has completed a certain journey, arriving at a place of destination, within the glass shade which covers the lock, and stand. The lock can be taken from its stand at any time, and be examined by anyone who may unlock it by means of its key, locking it again himself. Without the key the lock is as stubborn and defiant to the outsider as an everyday mule.

INTERIOR WIRING.

BRANCH CIRCUITS.

BY CHARLES E. KNOX.

Having treated in the previous article of the system and method of wiring, we now come to the problem of laying out the branch circuits.

In the article printed in the February issue we discussed the matter of locating the outlets and lights, and of securing available points for distributing centers and rising points. Before starting to lay out the branch circuits we should obtain from the architect a drawing of the floor construction, showing the space between the top of the beams and girders, and the flooring. In fireproof buildings of iron or steel construction it is almost the invariable practice, where the work is to be concealed, to run the conduits over the beams, under the rough flooring, between the sleepers, when running parallel to the sleepers, and by notching them where running in a perpendicular direction (see Fig. 1). In wooden frame buildings the conduits run perpendicular to the furring (see Fig. 2); they are also sometimes run below the beams. In the latter case the beams have to be notched, and this is only allowable in certain places, usually near the points where the beams are supported. The architect's drawing is therefore necessary in order that the location and course of the conduits may be indicated on the plans.

In discussing the question of distributing the outlets, we selected a dwelling house by way of illustration. For the present, however, we will not confine ourselves to any particular type or class of building, but will consider the problem in a general way, making reference where necessary to points of difference which should be made in the wiring, dependent upon the type of building to be wired. In general, however, unless it is stated to the contrary, our remarks will apply more particularly to buildings which have not been completed before the wiring is installed. These cases form a large majority of the total number. In a later number of the series we will take an example of a completed building and treat more fully of the method of wiring it.

The first point for consideration in laying out the branch circuit work is the number of outlets and the number of lights which may be wired on any one branch circuit work. The rules of the National Board of Fire Underwriters, which are the rules that generally govern electrical work in this country, do not restrict the number of outlets that may be connected to one circuit. The number of lights, however, which may be wired on one branch circuit is limited by the current-carrying capacity of the wire. As No. 14 wire is the standard size for branch circuit work, we will take it as a basis. Of course, No. 12 is very frequently used, but it is advisable to use this or larger sizes only when necessary to reduce the loss in an unavoidably long branch circuit. The allowable current-carrying capacity for No. 14 wire, according to the latest rules of the National Board, is 12 amperes for rubber-covered wire and 16 amperes for weatherproof wires. The number of lights on any circuit is further restricted by the rule in regard to automatic cut-outs (fuses and circuit breakers), which requires that cut-outs "must be so placed that no set of incandescent lamps, whether grouped on one fixture or several fixtures or pendants, requiring a current of more than six amperes, shall be dependent on one cut-out." Of course, we can comply with this rule and yet carry more than six amperes on a branch circuit, by using fixture or local cut-outs. These fixture cut-outs are so objectionable, however, that it is much better to limit the current on the circuit to six amperes and place all the fuses in cut-out cabinets.

This rule may in some cases seem a handicap, but the factor of safety in the carrying capacity of branch circuits should be sufficient to allow the number of amperes to be at least doubled. The reason for this is that it is very common to entirely replace the 16-c.p. lamps on a branch circuit by 32 or even higher candle power lamps. Then, too, it is such a simple matter to extend a circuit or make a "tap" on an existing outlet for additional outlets (and this, too, generally without the knowledge or permission of the electrician in charge of the plant), that it is wise to leave ample margin in the branch for using higher candle power lamps and for circuit extensions. All things being considered, it is probably best to limit the number of lights on a circuit to eight, or at the outside ten, 16-c.p. lamps, the lower number being preferable in the majority of cases. (We assume here that 110-volt lamps, and not not 220-volt lamps are used.)

In determining the number of outlets on a circuit, it is well to remember that each outlet connection is a possible source of trouble. For this reason it is wise to keep the number of the outlets on a circuit at the lowest point consistent with economical wiring. It has been proven by actual practice that the best results are obtained by limiting the number to five or six outlets on a branch circuit. Of course, where all the outlets have a single light each, it is frequently necessary, for reason of economy, to increase this number to eight, and in some cases to ten outlets.

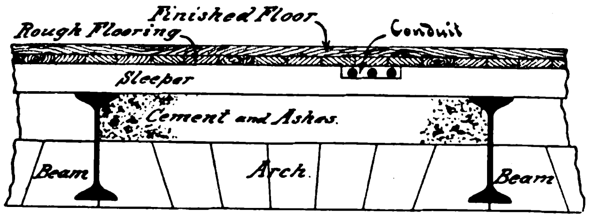


FIG. 1.—FLOOR CONSTRUCTION IN IRON FRAME BUILDINGS.

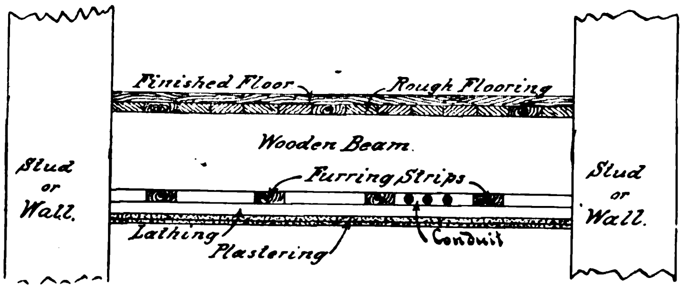


FIG. 2.—FLOOR CONSTRUCTION IN WOODEN FRAME BUILDINGS.

We have already referred to the location of the wires or conduits. This question is generally settled by the peculiarities of the construction of the building. It is necessary to know this, however, before laying out the circuit work, as it frequently determines the course of the circuits.

Now, as to the course of the circuit work little need be said, as it is largely influenced by the relative position of the outlets, cut-outs, switches, etc. Between the cut-out box and the first outlet, and between the outlets, it will have to be decided, however, whether the circuits shall run at right angles to the walls of the building or room, or whether they shall run directly from one point to another irrespective of their angle with regard to the sleeper or beams. Of course, in the former instance, the advantages are that the cost is somewhat less, and the number of elbows and bends is reduced. If the tubes are bent, however, instead of using elbows, the difference in cost is usually very slight, and probably does not compensate for the disadvantages resulting from running the tubes diagonally. As to the number of bends, if the branch circuit work be properly laid out and installed, and the proper size tube used, it rarely happens that there is any difference in "pulling" the branch circuit wires. We may happen, in the event of a very long run, or one having a large number of bends, that it might be advisable to adopt the short and most direct route.

The advantages of running the tubes at right angles to the walls of the building or room are, that the tubes may be grouped much better at the cut-out cabinets; there is much less damage to the sleepers where they have to be notched, a more symmetrical and workmanlike piece of work is obtained, and there is less trouble where tubes cross each other. It very frequently happens that there is very little space between the top of the beams or girders and the finished floor, and when this is true, it is more difficult to keep the tubes down when they run diagonally than when they run at right angles.

It very frequently happens when the tubes are run diagonally that several tubes cross each other at one point, the result being that there are three or more tubes, one on top of the other. If the tubes were run at right angles on the other hand, this would be easier to avoid and much less likely to occur.

The greatest disadvantage of running the tubes diagonally, however, is the demoralizing effect it has on the workmen. It undoubtedly has the tendency to make them run the tubes "any old way," so long as they are continuous; moreover this effect is not limited to the conduit work alone, but is apparent thereafter through the entire installation.

A FACTORY TELEPHONE SYSTEM.

BY D. H. FITCH.

I was asked to furnish a telephone system to connect the several floors and departments of a large sash, blind and door factory.

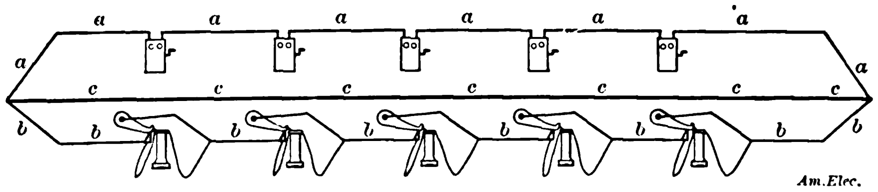


FIG. 1.—GENERAL PLAN OF CIRCUITS.

The conditions to be met were, the noise, vibration and dust from high-speed woodworking machinery, and, prospectively, light and power currents in the building.

There was, so far as I know, no system that would answer. The noise and vibration were extreme, and dust did not permit of any switches in the main circuit.

I aimed to devise an inexpensive system, which would fully meet all of the requirements.

Of the accompanying diagrams, Fig. 1 illustrates the general plan of circuits, and Fig. 2 the details of a station. Fig. 3 shows the transmitting and receiving apparatus. Three wires are employed. The call bells are in series on the call wire, a, Fig. 1; the speech apparatus in series on the wire, b, and c, serves as the return wire for both sides.

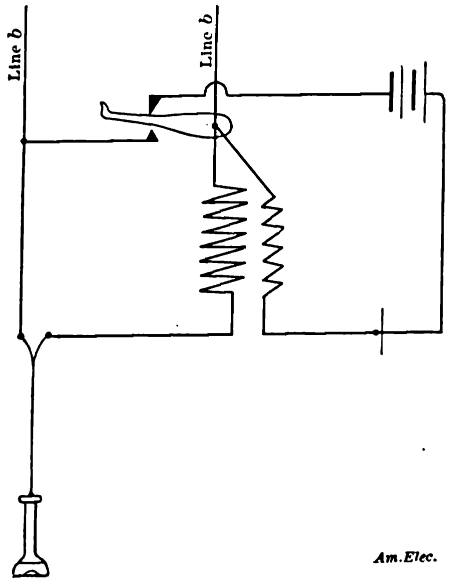


FIG. 2.—DETAILS OF A STATION.

The call boxes are plain magneto bells, with none of the usual telephone switches. At the stations, Fig. 2, the upward movement of the hook lever closes the transmitter battery circuit, and the downward movement connects together the two line terminals, thus shunting the transmitter and receiver.

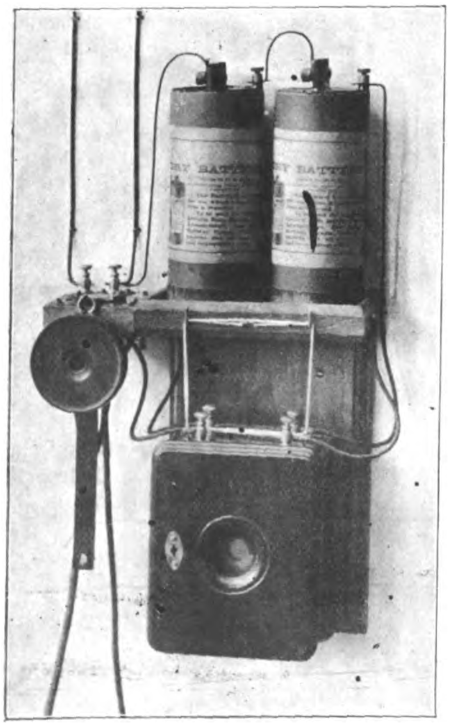


FIG. 3.—TRANSMITTING AND RECEIVING APPARATUS.

The main circuit is never broken, and hence there is no possibility of interruptions due to defective spring contacts—a necessary provision where there is so much dust.

The speech apparatus is placed in soundproof inclosures, and the bells so located outside as to be best heard by the foremen.

The transmitters are suspended on elastic cords, and connections made by means of flexible conductors. The lines between the stations are in the form of a twisted three-wire cable, and hence silent as to light or power currents.

There being no impedence in the speech circuit while the telephones are on the hooks, the number of stations which can be worked in series is limited only by the number of bells which can be rung.

The system has worked very efficiently—in fact more free from disturbance than telephone systems in general. It was put in use in September, 1896, and thus far has required no repair, other than replacing exhausted batteries.

SOME WORKSHOP HINTS.

BY JAMES F. HOBART, M. E.

The armature builder's lot is not always a happy one, mechanically considered, for he has many troubles to contend with which do not always appear upon the surface. For instance, in packing up an armature core, it is a very tedious operation to get the core equalized so it will not be either crooked, or one side longer than the other. Some of the trouble met with in this line is caused by the unequal thickness of the iron from which the disks are punched. Secure the best rolled sheet of iron possible, and cut a transverse strip from it. Careful measurement with a micrometer will show that the iron is thicker in the middle than it is at either edge, and if an armature core be built up from disks cut from one side of a sheet, as shown at *A*, Fig. 1, it will be crooked when the bolts are tightened up, in spite of all that can be done.

A partial solution of this difficulty is to reverse the die to the position shown by *B*; that is, with the key-way in direction of the length of sheet. With the blanks punched in this manner, it is possible to reverse every alternate disk when packing up the armature core, and thus, to a certain extent, pile the disks " tips and butts " like a bunch of shingles. This will prevent the core from being crooked when tightened up, but it will not prevent portions of the circumference from being solid while other portions are slack. Still, it enables a very good core to be built up, and as no material or workmanship is perfect, the result answers very well for the purpose for which intended.

How many builders of generators and motors have studied the proper relation between thickness of commutator segment and thickness of the mica insulation? There is a relation, and a vital one, regarding the life of the commutator and its freedom from sparking. There is considerable difference in the behavior of copper and mica, when both are subject to the same wearing pressure, as in a commutator.

If a special commutator was made up with one-half copper, and the other half mica, and exposed to the action of brushes, what would be the probable condition of that armature after a month of steady wear? Probably the copper and mica would wear differently, one faster then the other. Make another commutator with four copper segments and four mica insulations between, each ½ in. thick, and see how the brushes behave after they have been running on that commutator for one month.

It will be found that the commutator does not wear well when the mica is too thick, and that there is a certain relation between the thicknesses of the two, which makes the difference between a good and a bad wearing commutator. In many commutators put out with machines, the mica is too thick, and does not wear down fast enough to accommodate the wear of the copper. We all know what happens when a ridge, or a series of ridges, are formed on a commutator—that the brushes gouge into the copper just beyond each ridge, making it impossible to keep the commutator in good order, or the machine from sparking. This relation might be profitably studied by a number of concerns that manufacture commutators.

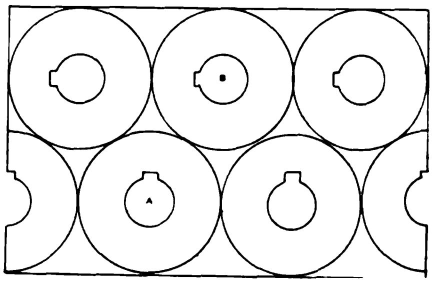


FIG. 1.—PUNCHING ARMATURE DISKS.

One thing which all shops might profitably install is some device whereby shafts and mandrels can be forced into and out of hubs or holes. It is too much like " the good old times " to see two or three men with sledges, one man with a copper hammer or a bar of babbitt metal, and another man holding the work—all these men congregated around a miserable little wheel, gear or drum, engaged in pounding a shaft into it.

Just sit down and figure the actual cost of forcing a shaft home by such means, then figure out what it would cost to do the work with a wheel press or some form of home-made hydrostatic rig, in which power is applied by a 10 or 20 ton "whisky jack," as shown in the outline, Fig. 2.

Every shop ought to have a couple of these useful tools, and they can be used for other work besides mandrel pressing, but, better, get one for this purpose alone, and rig it up specially for that purpose. Then it will be where it belongs when wanted. The ordinary V-shaped mandrel driving stand may be used in constructing this, but better get one on purpose for it and let the hand drive stand alone.

Get a couple of pairs of I-beams, long enough to span any work likely to be put into the press, and stout enough to stand the strain of the jack at the length wanted.

Any catalogue of architectural iron will give the dimensions necessary for this. Separate the pairs with a few inches of iron, and bolt the whole together. This leaves a space between the I-beams for a shaft or mandrel to be put through. Connect the two pairs by means of two heavy rods, with shoulder plates at top and bottom to engage the pairs of I-beams, and nuts and washers to screw up outside of the beams.

Make the rods long enough so that the driving block already mentioned, can stand inside when the frame is put together, and still leave room for the length of the jack, and the work that is to be done. Some whisky jacks will work when placed bottom end up. If you have one of this kind, invert it, and belt it to the upper pair of I-beams. If the jack will not work inverted, belt the head to the top of the frame, and attach a coiled spring heavy enough to pull the jack together when the lever is reversed, and the pump valve tripped.

A rig of this kind, with a 20-ton jack, need not cost more than $100, and with it, one man can do more and better work than the six men mentioned above, with all the sledges they can get on to the work. The quality of the work done by apparatus of this kind is much better than that done by hand, as the progression of a mandrel is by steady pressure, instead of by a succession of jerks that must be very hard on the cast iron hub. Indeed, on more than one occasion, the writer has seen castings ruined by one of the strikers missing his aim, and the force of his blow, carrying away an arm, or a segment of the rim of a pulley or wheel.

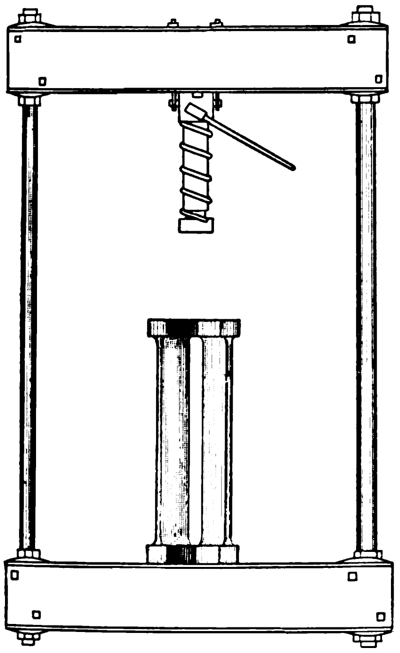

Am.Elec.

FIG. 2.—HOME-MADE MANDREL PRESS.

The writer recently was shown a very ingenious arrangement of a circular saw for the A. B. See Company, and is for the getting out of elevator work, cleat work molding of special grooves, etc., used in connection with electric elevator work. The saw in question was mounted beside a sliding carriage much the same that an ordinary edging, or "jointing" saw is hung. The peculiarity of this machine is, that the saw should be revolved through an arc of about 60 degs., so as to either cut "square" with the face of board, or to swing around within 30 degs. of parallel therewith.

The saw arbor was mounted in a frame which could be revolved to the desired angle, and then made fast. The belt was kept on the saw pulley by having a long drive pulley to travel on and a guide pulley of the same length to take the belt into the right direction. The saw could have its angle changed in a very few seconds, while running or while at rest.

This arrangement displaces the usual rigging up of tilted rests or fences, and enables the work to be laid flat on a sliding carriage and then, in that position, pushed past the saw. The fence method requires that the work be held in position by the workman and at all times guided by him so as to keep the saw on the line where the cutting is required. In fact, it makes as much difference in the accuracy of the work, as it does when a man who has been trying to grind a straight surface on the edge of an iron bar, is given a planer or milling machine on which he can fasten the work securely, and in that position send it past the cutting tool.

I am not informed that any patent has been applied for in connection with this machine, and think it possible that arrangements could be made with the maker whereby the use of the machine, or even castings therefor, could be procured at a slight expense. The machine would make a unique and most desirable addition to the machine shop tools. For the pattern maker alone, it will be worth much more than its cost.

ELECTRIC RAILWAY PRACTICE.

BY EUGENE C. PARHAM.

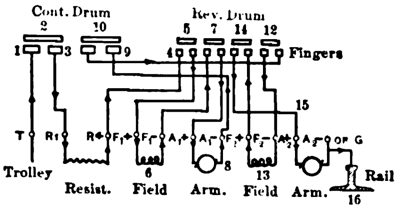
INSTALLATION.

In the previous articles all of the wires, with the exception of several inside the controller, which carry the current of both motors under all conditions, have been gone over, and therefore if there is any trouble it must be between the trolley and ground controller connecting posts.

To proceed with the test we had best have some knowledge of the car wiring diagram of the system in question; that is, a knowledge of the order in which the current from the trolley enters the several devices on the car, and the relation borne by the terminals of these devices to the lettered or numbered binding posts on the controller.

A careful reader may take exception to the expression, "order in which the current enters the several devices," thus, in a measure, defining the current direction as something to be determined; but such is not the meaning to be construed, as we wish merely to signify the relative positions of devices in regard to the grounded and ungrounded sides of the circuit. The question is often asked: "On your equipment, which does the current enter first, the armatures or the fields?" Now this is a very natural way of putting the question, supposing, as is generally the case, that the trolley wire is positive, and that the current flows, therefore, from the wire toward the rail. But the polarity of the wire is really immaterial, except in special cases, as is evidenced by the fact that there are roads running with negative wire and positive rail, in which cases the order in which the current enters the devices has been reversed, but the position of the devices, relative to wire and rail, has not. A more correct way to put the question would be, then, "Which lies nearest the trolley wire, the motor field or the armature?" or "Which do you ground, the field or the armature?" A general answer to the question is, some systems ground the field, and others the armature. The advantages and disadvantages of the two methods will be discussed elsewhere.

On all systems of wiring it is customary to designate the terminals of the various devices by means of the initial letters of their names. These letters are further modified to distinguish the different leads coming from the same device, and, further, the letters are stamped on the controller connecting posts, so the most inexperienced wireman may readily see to what part of the controller the variously tagged hose wires should go. In Fig. 2 we have selected the most common system of lettering, and have further facilitated following the path of the circuit from trolley to rail by adding the arrow heads and numerals. Fig. 2 gives the path of the current on an actual controller, when the drum rests on the first notch series, and the reverse drum is at "go ahead." 1, 2, 3, 4, etc., up to 16 gives the path of the current, as indicated by the arrow heads. In this diagram, all parts not used on the first notch series have been omitted.



Am.Elec.

FIG. 1.—PATH OF CURRENT ON CONTROLLER

We will now resume the test and locate a fault supposed to exist somewhere between connecting posts T and G, in diagram 2. With both hood switches closed, we attach one test line permanently to T, and with the other touch successively posts R 1, R 4, F 1 +, F 1 —, A 1 +, A 1 —, etc., to G. As soon as we touch a post which is nearer the ground than the fault, the test circuit bridges the fault and offers a path to earth through the lamps, which will then glow. Suppose an open circuit to exist between the finger marked 1 and the drum contact ring marked 2; then if no other open circuit exists in the connections the lamps will glow as soon as we touch post R1, and this will prove the trouble to lay between T and R1; but we do not yet know whether the fault is in the wire connecting T to finger 1, or in the failure of contact between 1 and 2, or 2 and 3, or whether it is in the wire connecting 3 and R4. To determine this, touch successively 1, 2, 3 and R4.

Conditions are much complicated where two open circuits happen to exist, for then although the test lamps may bridge one open circuit, there will be another in series with them, so no current can flow, making the indications misleading. To detect such a state of affairs, proceed as follows:

Suppose open circuits to exist between T and R1 and also between A1 + and A1 —; keeping one test line on G, begin at T, and touch R1, R4, etc., until a post is touched where the lamps fail to glow. In this particular case the post will be R1, locating the fault between T and R1; next, attach a test line to T and move the ground test line from post to post in the reverse order. As soon as we touch A1 + the lamps will fail to glow, showing the fault to exist between A1 + and A1 —, that is, in the armature or in one of the wires leading to it. Where more than two open circuits exist, two of them must be located as above and removed before the others can be conveniently sought.

Points about an equipment most apt to give open circuit troubles are, poor connection between trolley stand and roof wiring; defective hood switch; loose controller connection, controller finger making no contact; resistance coil burnt out; motor field or armature lead burnt off; a blown fuse; weak brush springs, short brushes, brushes tight in the holders or absence of brushes altogether; ground terminal burnt off; loose two-way connector, and a dirty or dead rail. A car shed electrician is generally familiar with the weak points of all those equipments under his charge, and can usually locate most of his troubles by a careful inspection.

Consideration at length of what ailments certain symptoms indicate will be deferred until we shall have considered short circuits and open circuits on specified plans of wiring.

If upon throwing the controller on and off a flash is observed, it shows the circuit to be closed, and if the car refuses to respond, the indications are that either motors are opposed, or some more serious wrong connection exists. By trying one motor at a time it can be determined whether they concur in direction or not. Should the motors start the car in opposite directions for a given position of the reverse handle on the controller, ascertain if the same is true on the other controller. If so, one motor's field or armature leads must be reversed. If not so, or if the car has but one controller, the change can be made at the controller.

Trouble due to interchange of wires in wiring the controller generally declares itself very forcibly when the controller handle is advanced beyond the resistance points. The actual symptoms consequent upon some error in wiring will be deferred to a consideration of the several systems of car wiring in detail. Should the car start in the same direction, whatever the position of the reverse handle, it shows the reversing gear to be mechanically defective, i. e., although the reverse handle turns to indicated positions, some missing pin, screw or key prevents the switch or drum from turning with it. The writer knows of but two occurrences of this uncommon trouble.

If upon throwing the handle of the controller to the "off" position, the car gives a sudden lurch forward or backward, according to the position of the reverse handle, it means that for some reason which should not exist, the drum contact rings, which should come into action only on the last notch, have been allowed to swing around and make contact with the fingers. This may be due to any of several causes. 1. Some of the drum rings may overhang too far. 2. Some of the drum castings may have become loose and shifted on the drum shaft. 3. The index wheel may have slipped around. 4. In the shop the "piece worker" may have relied too much on the stop on top the cover and neglected to adjust the index wheel so the pawl dropped clean into the curved notch made especially for the "off" position. 5. Some change might have been made in the depth of this notch or in the size of the pawl wheel to secure smoother or more decided action of the notching spring. All of these defects might exist and yet remain inoperative until the controller handle were thrown off with force enough to exaggerate the evil.

If the series parallel controller is used, and the car seems to start all right with both motors cut in, it might lead one to think that both motors are in good shape when such may really not be the case. When two motors are in series, one of them may be badly grounded and the good motor do all the work of starting. In such a case the bad motor would not indicate its condition until the controller handle reached a multiple notch, in which case the two motor circuits being independent, the bad motor would declare itself violently. To avoid any such complications, always try the motors one at a time.

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LESSONS IN PRACTICAL ELECTRICITY

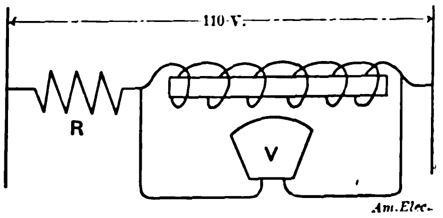
APPLICATIONS OF CONDENSERS IN ALTERNATING CURRENT WORKING.

In the several preceding articles the principles of inductance and capacity were developed, and simple methods given for calculating problems in which these quantities appear. In this article some of the practical applications of condensers will be pointed out.

Before proceeding we would strongly renew our advice to central station superintendents to make a condenser of about 5 microfarads' capacity, according to the instructions given in the preceding articles, the condenser to be used as described for showing alternating current paradoxes—that is, the effect of placing capacity and inductance in parallel and in series. As stated before, such an apparatus could not only be used for the edification of visitors to a station, but—which is of more importance—would enable the owner to obtain a most excellent insight into alternating current phenomena. We hope in an early issue to describe such an apparatus, complete, as one is now being constructed in order to furnish the necessary data.

There are at least three methods in which condensers may be practically applied in current work. One of these, as shown in the preceding articles, is to nullify the reactance of an inductive circuit, thereby causing the circuit to offer no more resistance to the passage of an alternating than a direct current. Another application is in obtaining higher voltages than the voltage of a given alternating current circuit. A third application is in connection with regulating apparatus.

The first mentioned application has been quite thoroughly developed in the preceding articles, so that it will not be here treated at length. As in any practical problem, the given quantity will be an inductance and not a capacity, the data of the first mentioned will have to be determined, and then the necessary size of condenser calculated; that is to say, the self-inductance of the inductive circuit must be determined in henrys.



TO DETERMINE FREE AND IMPRESSED E. M. F.

To determine the self-inductance it will be necessary to know the drop due to the passage, first, of a given direct current; and second, of a given alternating current, the frequency of the latter being known. If access to the station in which the alternating current is generated may be obtained, the frequency can be very accurately determined by finding the r.p.m., multiplying these by half the number of poles of the alternator, and dividing the product by 60. To be very exact, a station tender might be requested to take the revolutions at a given time, corresponding to the time when the measurements are being made.

Referring to Fig. 1, suppose the inductance is in the form of a choking coil. If the resistance of this coil is known, then a source of direct current will not be necessary. Should the resistance not be known, it may be determined by passing a direct current through the coil and noting, by means of a voltmeter, the drop between its extremities. If, for example, the coil is placed across a 110-volt circuit in series with a resistance such that, say, 2 amps. will flow through the coil, and the voltmeter shows that the drop in the coil with this current flowing is 40 volts, then, according to Ohm's law, the resistance will be the voltage divided by the current, or 20 ohms.

Next, the coil is connected across, say, a 100-volt alternating current circuit having a frequency of 133, and it is found that 1¼ amps. pass, which corresponds to a drop of 80 volts for a current of 1 amp. That is to say, with an alternating current of 1 amp. flowing, the drop in the coil is 80 volts or the impressed e.m.f. between the terminals is 80 volts; and when a direct current of 1 amp. flows, the ohmic drop will be 20 volts. Referring now to the triangle of Fig. 2, the impressed e.m.f. is the hypothenuse and the ohmic drop the perpendicular. As the inductive e.m.f. is at right angles to the free or ohmic drop, it will be represented by the base of the triangle, whose value may be found by subtracting the square of 20 from the square of 80, which will give 78 volts as the inductive e.m.f., corresponding to 1 amp. It may here be remarked that in the case of a coil having an iron core, the free e.m.f., corresponding to the perpendicular of the triangle, may usually be neglected, and the inductive e.m.f. assumed equal to the impressed e.m.f., represented by the hypothenuse of the triangle.

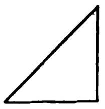


FIG. 2.—INDUCTANCE TRIANGLE.

To determine the value of the self-inductance in henrys, we substitute the formula

$$E = \frac{2\pi n L C}{1000}$$

where L is the self-inductance, n is the frequency and C is 1 amp. Solving this formula, we find that the self-inductance is 93 millihenrys.

Suppose that we had an inductive circuit through which, with a given circuit voltage, we wish to pass the maximum current. That is to say, normally too small an amount of alternating current passed, owing to the choking action of the inductance, and we wish to neutralize this choking action by placing a condenser either in parallel or in series. As has previously been shown, the inductance will be neutralized when the inductive e.m.f. caused by the flow of any current is equal to the capacity e.m.f. that will be set up by the same current, for the reason that these two e.m.fs. act opposite to each other. In other words, if we place the formula for inductive e.m.f. equal to the formula for capacity e.m.f., and find therefrom the value of k, this will give the size of the condenser necessary to neutralize the inductance; or

$$\frac{2\pi n L C}{1000} = \frac{1000000\, C}{2\pi n k}.$$

As we know the value of n and L, and C is unity, we can determine k, which will be the value required. Solving for the inductance just calculated, we find that a condenser of 15.3 microfarads will be necessary to neutralize the inductance of 93 millihenrys.

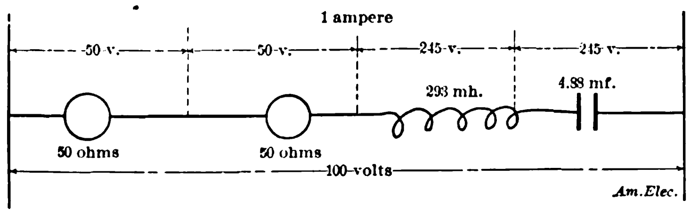


FIG. 3.—INDUCTANCE BALANCED BY CAPACITY.

The same result might have been obtained by placing the 78 volts above found equal to the second term of the capacity formula, or

$$\frac{1000000\, C}{2\pi n k} = 78,$$

whence $k = 15.3$.

A condenser of 15.3 microfarads capacity, however, is very large, as it would probably require over 500 sheets of tinfoil 1 ft. square, if paraffined paper is the dielectric. For an inductance twice as great, the condenser would be half the size above given, and for one ten times as great, one-tenth the size, as the above formulas show that the capacity is inversely proportional to the inductance.

The condenser has been applied in the above manner to polyphased motors, both in series and in parallel,to overcome inductance and thereby decrease the so-called idle current and the size of motor for a given power. Prof. S. P. Thompson has proposed as a solution to the problem of submarine telephony the use of a cable with inductances placed in circuit at short intervals to neutralize the capacity of the cable.

We will next take up the case showing how higher e.m.fs. than that of a given circuit may be obtained by means of a condenser and inductance in series. Referring to the diagram of Fig. 3, suppose we have 4.88 microfarads in series with an inductance of 293 millihenrys. As these values of inductance and capacity have been so chosen that they will neutralize each other, the circuit will act toward alternating current the same as direct current; in other words, the resistance of the choking coil alone will affect the flow of current. Consequently, in the case illustrated,where the voltage of the mains is 100, two 50-volt lamps placed in series will burn at full candle power 1 amp. of current passing.

It may be very easily shown by the formulasfor inductance and capacity that the inductive e.m.f. and the capacity e.m.f. are each 245 volts. That is to say, notwithstanding the fact that the voltage of the circuit is only 100 volts, a voltmeter connected at the extremities of either the condenser or choke coil will show a voltage of 245 volts. By having an adjustable condenser, and a choke coil whose windings may be thrown into different combinations, a range of voltage in the case given may be obtained up to 245 volts. It will be seen that such a combination of an inductance and condenser corresponds to a step-up transformer, and that by its means a source of voltage much higher than the circuit voltage may be obtained for, say, the calibration of instruments. If a choke coil is so wound that its windings may be thrown into various combinations in parallel, or some cut out entirely, voltages below that of the circuit may be obtained, an inductance in this manner thus acting as a step-down transformer.

Prof. Fessenden has suggested that a combination of a condenser and inductance in series may be used for regulation, and the reason will readily be seen by referring to Fig. 3.

For example, if the regulating apparatus is placed between the terminals of either the condenser or choke coil, a drop of 5 per cent or 5 volts in the circuit voltage will produce a drop of 5 per cent or 245 volts, or 12.25 volts between the terminals of the condenser or inductance. By having a still larger inductance in circuit, together with a smaller condenser, a still great difference between the circuit and inductance drop may be produced. In fact, the only limit is in the size of the inductive coil and the amount of strain that the condenser will withstand. The advantage of this method of regulation is that it magnifies the amount of a circuit drop. Consequently if it is desired to have a very close regulation, by means of the above disposition a considerable difference of voltage may be obtained to work the regulating apparatus.

As above implied, the larger the inductance the smaller the condenser necessary to nullify it. This follows from the fact that with a given current flowing, the smaller the condenser the greater will be its charge per unit of area, and consequently the greater the difference of potential between its terminals. At the limit an infinitesimal current would produce an infinite e.m.f. at the terminals of a condenser of infinitesimal size.

On the other hand, with a given current the larger the inductance the greater the e.m.f., for the reason that an increase of inductance implies an increase in the number of turns of the coil, which introduces more lines of force into the coil for a given current, with the result that there are more cuttings of lines of force at each alternation, thus producing a higher voltage between the terminals.

Letters on Practical Subjects

Live Wires.

To the Editor of American Electrician:

Referring to the letter from Mr. James Francis, in the February issue, I can see no reason for his criticism of Mr. A. W. Lee's solution of the "three-wire, two-station" problem, in the January issue. He argues that the third or neutral wire remains unbroken and *alive* at all times, no matter whether the lights are "on" or "off," and wants to know "if the insurance inspector would permit, or accept a job done that way."

Mr. Francis will find in all the diagrams of three-way switch circuits, that have been in preceding issues, that there is not a foot of wire in the circuit that is not *alive* at all times, even when the lamps are extinguished. Of course, some of the conductors get their connection through the lamps, but enough current would flow through three or four lamps to start a fire under certain conditions. Even the common, every-day wiring of private residences is just the same in regard to *live wires*. A 5-amp. single-pole switch controlling six lights leaves "live wires" on both sides of it when it is "open." A 10-amp. double-pole switch leaves "live wires" back to the cut-out, and from there to the main entrance.

Again, if Mr. Francis will look more closely over Mr. Lee's diagram, he will find that there are lots of other "live wires" there at all times, besides the middle wire. The only switch that the inspector calls for to "open" all three wires is the main entrance, or service switch, and as Mr. Lee's arrangement of switches is not intended for service switches, I can see no reason why the inspector should condemn them. But, if he should condemn this circuit, then he should do the same in the case of all others for they are all *alive*. Edgar A. F. Herbert.

Dover, N. H.

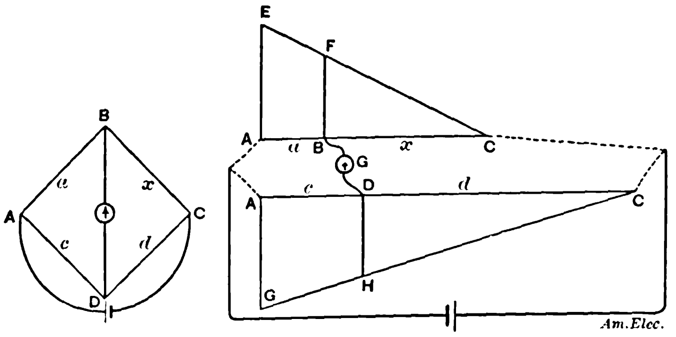
◆

Principle of Wheatstone Bridge.

To the Editor of American Electrician:

The article in your January issue and the letter of Mr. Eastlake in the February number, while illustrating the principle of the Wheatstone bridge, both neglect to give a proof of the proportion existing between the arms when balanced. Following is a simple form of proof:

In the bridge diagram, Fig. 1, there are, of course, two circuits, $A\ B\ C$ and $A\ D\ C$, and the fall of potential on these two circuits may be represented by the two right-angled triangles $A\ E\ C$ and $A\ G\ C$, the two base lines $A\ B\ C$ and $A\ D\ C$ representing by their length the resistances in the two circuits.



PRINCIPLE OF WHEATSTONE BRIDGE.

The potential at the point A is the same in both circuits (since it is a common point for both); that is, $A\ E = A\ G$. Also, when there is a balance there is no current flowing through the galvanometer G; therefore $B\ F = D\ H$. The two triangles $A\ E\ C$ and $B\ F\ C$ are similar triangles, because the angles $E\ A\ C$ and $F\ B\ C$ are right angles and the angle $E\ C\ A$ is common to both.

Therefore the third angle of both triangles is equal, since the sum of the angles of any triangle is equal to two right angles. As the sides of similar triangles containing equal angles are proportional,

$$A\ E : A\ B + B\ C :: F\ B : B\ C.$$

Similarly with the two triangles $A\ G\ C$ and $D\ H\ C$,

$$A\ G : A\ B + D\ C = D\ H : D\ C.$$

Since $A\ E = A\ G$, and $F\ B = D\ H$, we have

$$A\ B + B\ C : A\ B + D\ C = B\ C : D\ C.$$

Substituting the small letters representing the resistances, we have $a + x : c + d = x : d$; reducing the proportion, we have $a : c = x : d$, or $x = da\ /c$.

Denison, Tex. James R. Pratt.

◆

Electrical Sport.

To the Editor of American Electrician:

Some time ago, when in the employ of the electric plant in a Southern town, I was sitting one day in our storeroom—a small room opening into the public market—with my helper, wiring some new fixtures just received. While busily employed in our work a little negro, who had been left in charge of the lunch counter in the market, finding business dull, came over and amused himself by bothering us. After a while he was called away by a customer, and while he was gone we decided to give him a surprise when he returned. We took one wire from a 15,000-ohm magneto and connected it to an old grate bar, which we placed on the ground near the door. We then found an old piece of water pipe about three feet long, with a faucet screwed on one end, and to this we connected the other wire and placed it where the boy could reach it conveniently when he returned. I took the magnet in my lap and had my helper cover the wires with some wrapping paper.

In about half an hour the boy returned, and not suspecting anything, he stood with both bare feet on the grate bar and took the pipe up and tried to blow through it. Finding the faucet closed, he reached down with one hand to turn it on, holding the pipe in his mouth with the other hand. While so situated I gave him the full strength of the magneto. He dropped the pipe with an unearthly yell and fled in terror, not knowing what had struck him. It is needless to say we were not bothered again by the gamin.

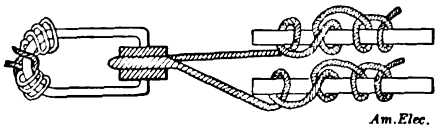
New Orleans, La. A. C. Jones.

◆

A Come-Along Kink.

To the Editor of American Electrician:

Noticing in your March issue an illustration of an improvised come-along, I send herewith a sketch of one somewhat on the same principle but much superior in operation, since the former would have a tendency to kink the wire. This is made by taking four half-hitches about the wire and close together; the rope is then run around a No. 1 porcelain insulator, through the hole in which a link of No. 4 wire passes, the tackle making fast to the latter. This makes a very handy arrangement to pull two wires at the same time. The knot can be slid along the wire without untying.



COME ALONG.

Wallace Belmont.

Omaha, Neb.

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Dry Cells.

To the Editor of American Electrician:

Referring to the letters of Messrs. Townsend Wolcott and P. M. Heldt, in the last issue, I wish to state regarding the connection of the cells, that they were all properly connected, as was proved during the testing of each cell for e.m.f. with the voltmeter. The instrument I used was a new meter, reading to 10 volts by about 3-16 in. spaces per volt on the scale. I connected the cells in series, and, with an insulated wire in either hand, leading from the voltmeter, I touched the binding post of each cell, and held the wires there just long enough for the voltmeter needle to come to rest, no longer.

I then would take the voltage across all the cells in the same manner. I had a suspicion that something might be not right with the voltmeter, and to make sure, I applied the connections above described to the binding screws of a small six-cell storage battery which happened to be freshly charged at the time. The voltmeter needle went right up to the graduation, as I touched the terminals in the same manner noted in with the dry cells. At 2, 4, 6, 8, and 10 volts, the Cherry instrument indicated the amount due to the given number of storage cells in series open circuit. I cannot, therefore, accept the supposition that the cells were wrongly connected, or that the voltmeter was not fairly correct.

The current derived from each cell was, by ammeter, about 1-6 amp. The resistance per cell, therefore, should have been about 6 ohms. I will here state that at the time of the measurements, and for a week before, the cells had not been used at all, except momentarily, for getting a balance on a Wheatstone bridge, with never less than several hundred ohms resistance in series with the battery. Therefore, polarization could not have amounted to much.

I do not understand Mr. Heldt's statement in the last paragraph of his letter, to the effect that to double the current derived from 6 cells there would be required "24 cells connected in two parallel groups of 12 in series." I would like to see a mathematical demonstration (algebraical preferred) of the matter, for I have been unable to figure the number of cells as he states it. N. F. Jarvis.

Philadelphia, Pa.

◆

Behavior of Dry Cells.

To the Editor of American Electrician:

I have no knowledge of the particular

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make of dry batteries mentioned by Mr. N. T. Jarvis, in your February issue, but they are probably not much better or worse than other dry cells would have been under similar conditions, and the data furnished by him afford ample means of determining their present state.

In the first place they are nearly worn out and have a very high internal resistance—about two ohms. His voltmeter, on the other hand, is of low resistance—probably not over 30 ohms; his working resistance is also very low, and therefore quite unsuitable for such work as he indicates.

The fact that he gets actually less current from the eight cells in series than from a single cell shows only that some cells are worse than others. He does not state whether the half ampere current from one cell was obtained on short circuit, or through a resistance; if the latter, the resistance must be so small as to be practically negligible beside that of the cell. The fact that there is no increase of current on increasing the number of cells shows that they are virtually on short circuit, and that ½ amp. is the full capacity of each cell (considering them uniform), and therefore we know by Ohm's law that the voltage of one cell divided by its resistance must be equal to ½ amp.

A low resistance voltmeter does not give the absolute voltage of a battery by direct reading, but it is really more useful for battery purposes than a high resistance instrument, as, indirectly, it can tell us not only the true voltage but also the resistance of a cell, if we know the resistance of the voltmeter. We are not told the voltmeter resistance, but we can get at it approximately through the other data.

Now, every voltmeter is in effect also an ampere-meter (or milliampere-meter), for the current passing through it is proportional to the voltage between the terminals, and if we know the resistance we can easily find the constant by which to multiply the voltage reading, to give us a reading in amperes or milliamperes.

We do not need this constant at all in this case, and insert it only to make the method clear. Call this constant A. Then A is the current sent through by one volt, $5A$ by five volts, and so on.

Just for example, let us assume in our present case all eight cells of equal voltage and resistance; then calling the true voltage of one cell E, the resistance of one cell R, and the resistance of voltmeter X, we have by Mr. Jarvis' readings,

$$\frac{E}{X+R} = A \text{ or } \frac{8E}{X+8R} = 5\tfrac{1}{2}A.$$

Simplifying, we readily get $X = 14.4\ R$. Now, in any circuit the voltage divides itself up in the same proportion as the resistances; therefore, with one cell in series with the voltmeter, the voltmeter gets 14.4 parts while the cell gets 1 part, and as the voltmeter gets, say, 1 volt, the cell must be using up 1-144 = .07 volt. The full voltage of the cell is therefore the sum of 1 and .07 volt = 1.07 volt. The voltage of the eight cells therefore will be 8.56 volts, but of this, when in series with the voltmeter, the voltmeter will get 14.4 parts while the cells absorb 8 parts. The cells therefore use up 8-22.4 of the whole = 3.06 volts, while the voltmeter shows only the balance of 8.56 — 3.06 = 5.5 volts.

Knowing, now, the voltage of the cells and the limiting current we easily get the resistance, for $1.07 / R = \frac{1}{2}$, therefore $R = .2.14$, which is roughly the ohmic resistance of one cell.

Mr. Jarvis will readily see that with such cells as these he cannot increase his current by adding cells unless he starts with a very high external resistance and a very small current. In all cases, if we wish the current to increase even approximately as the number of cells is increased, we must have the external resistance very high compared with that of the battery—the higher the better. If we must have a comparatively heavy current, then we must also use batteries of low resistance. While the ordinary cheap dry cell gives a voltage on open circuit of from 1.3 to 1.5 volts, and has a resistance of say .2 to .4 of an ohm, it is not suitable for sustained work, unless the current can be kept down to a very small fraction of an ampere by suitable resistance.

Mr. Jarvis would probably get more satisfaction from some other batteries now on the market, for there are some excellent ones of comparatively low resistance, and retain practically the same voltage, under a limited current, during the whole life of the cell.

The figures given relative to Mr. Jarvis's cells are approximate only, even if we assume the correctness of his voltmeter and ammeter. Owing to a rapid polarization, the voltage of an old dry cell is a very uncertain quantity, and it is quite likely after a rest his cells might show on a high resistance voltmeter, over 1.2 volts; but this static voltage is immaterial, for it is only the voltage in service that one really cares about.

V. C. Wynne.

Utica, N. Y.

ELECTRICA CATECHIS

197. What causes the armature of a motor to rotate?

It is caused by the magnetic effect of the currents in the armature wires which lengthen the path of the magnetic lines of force between the poles of the field magnet.

198. How can it be shown that there is a magnetic field due to the current?

A simple way to show that the current is surrounded by a magnetic field is to bring a compass needle near a wire that is carrying a current. If the wire is horizontal, and the needle is placed over or under the wire, it will be rotated by the current and will stand about at right angles to the wire (the wire should run north and south, so that the needle would naturally be parallel to the wire). If the wire is vertical, the needle will turn so as to be tangent to the wire. If the needle is moved around the wire, it will take different positions with its axis always tangent to a circle. A current of 10 amps. is strong enough to show these effects easily.

199. How can the magnetic field about a current be shown by iron filings?

Pass a wire vertically through a card or smooth board upon which iron filings or small chips have been sprinkled. Send a current of about 20 amps. through the wire and at the same time slightly jar the card so that the iron bits can move easily. They will gradually arrange themselves in more or less perfect circles, as shown in Fig. 1, which is taken from a photgraph. If one cannot easily get a current of 20 amps., he can get almost as good results by passing the wire through the hole several times, making a coil of large diameter so that the returning wires will not affect the field seriously. With practice and care in selecting iron bits of the right size, one can obtain clearly defined circles about the wire.

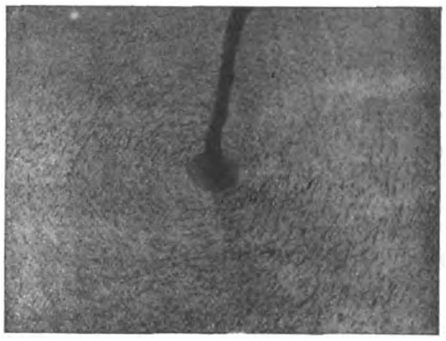

FIG 1.—MAGNETIC LINES OF FORCE.

200. Why is there a clear space close around the wire where there are no iron bits?

Near the wire the field is so strong that the iron bits are drawn to the wire and so leave the space clear for some little distance away.

201. How is the magnetic field about a wire affected by forming the wire into a coil?

Some of the lines will still surround the individual wires, but most of them will unite and pass through the entire coil as seen in Fig. 2, taken from a photograph. The field is seen to be strong through the center of the coil, so that the iron bits arrange themselves in quite definite lines, while outside the coil, the field is more scattered and not strong enough to collect the iron bits into so definite lines. It is seen that the magnet field is strengthened by the current in each wire; in fact, if the wires are close together, the total strength of field is proportional to the product of the current by the number of wires.

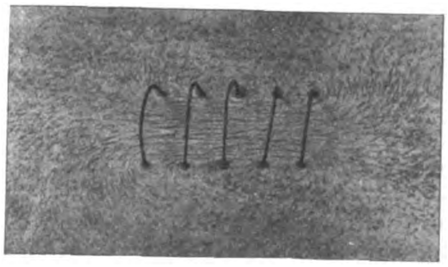

FIG. 2.—MAGNETIC LINES OF FORCE.

QUERIES AND ANSWERS

What resistance can I use with a 4.3 volt, .75 amp. dental lamp on a 110-volt circuit? A. R.

Connect two 110-volt lamps in series with one 110-volt lamp in parallel, and place the dental lamp in series with the combination.

Please recommend a good book on the steam engine and also one on the boiler. A. N.

Jamieson's "Steam and the Steam Engine" and Wilson's "Steam Boilers." There are two grades of the former, one elementary and the other more advanced.

What does the constant 21 mean in formulas for calculating the size of wires? F. E. F.

The resistance of a copper conductor 1 ft. long and having a cross section of one circular mil is 10.5 ohms. As the double conductor of a circuit is usually implied in wiring formulas, this then becomes 21.

How many amperes does the Wheelock 6 x 8 battery deliver? W. I. H.

None, if the battery is open circuited; short-circuited, the current is the quotient of the e.m.f. by the internal resistance; with an external resistance the current is the e.m.f. divided by the sum of the external and internal resistances.

I have an electric door opener which fails to operate satisfactorily; the armature is attracted more weakly the longer the button is pressed. What is probably the matter? F. W.

The battery is probably weak. A battery for this kind of work will naturally act as described when the button is pressed for any length of time, even if in good condition.

What size should a condenser be to work in multiple with an inductive resistance that takes 5 amps. at 100 volts? J. R.

What is the value of the inductive resistance? If the condenser is to nullify an inductance, it would be very large and expensive to make if 5 amps. are to flow—in this case not far from 60 microfarads capacity.

Referring to the article on worm gearing in February number, will the armature lock the wheels the instant the current is off; and if it does and the trolley cames off at high speed, will there not be a serious result? F. K.

The abruptness of the stop in case current is shut off will depend on the flywheel capacity of the armature, which in any practical case will be such as to cause the stop to be gradual.

How can static electricity be dissipated from printing paper? C. E. F.

In large newspaper offices steam is sprayed on the sheet as it leaves the roll; hot air has also been used for this purpose. In dry cold weather trouble from static electricity may be mitigated by keeping the atmosphere of a press room damp by means of a steam jet.

How can cross-talk be prevented on intercommunicating telephone systems where a cable is used? H. R. W.

In such a system, since some of the wires are in common, we know of no method of preventing mutual induction—that is, cross talk. It may be reduced by keeping the wires separated as widely as possible where a cable is not used.

How can I make a spark coil for a gasoline engine, to be used either in connection with a battery or a 50-volt direct-current circuit? G. C. D.

Wind about three pounds of No. 14 wire on a one-inch core of soft iron wire. Use four or five cells of a good sal-ammoniac battery, or a larger number of potash cells. Connect a 50-volt lamp in series when current is taken from a 50-volt lighting circuit; if a 16-c.p. lamp does not give a large enough spark, use a 32 c.p.

In some alternating current arc lighting systems, flat carbons are used in lamps. Of what advantage are they? M. P. C.

Flat carbons were, we believe, originally adopted in order to get an all-night lamp which would not infringe upon the Brush double-carbon patent. An advantage claimed for flat carbons is that the lamp is smoother in working, since the arc can travel along the ends of the carbon as it is consumed, thus requiring less action on the part of the regulating mechanism.

What is the no-load loss of small transformers and their efficiency at full-load? V. D.

In good transformers the loss is from 3 per cent of full load in 20-light capacity, to 1 per cent in 10-k.w. capacity. For example, the loss should not be greater than 30 watts in a 1000-watt transformer, or 80 watts in a 4000-watt transformer or 100 watts in a 10,000-watt transformer, the frequency being 133. For lower frequencies the loss is greater. The efficiency at the above losses and the higher frequency would be about 94, 95 and 97 per cent., respectively.

Can a Blake transmitter be used with a carbon pencil transmitter with satisfactory results? C. W.

Yes, provided each of the instruments is capable of giving good results alone. The secondaries of the induction coils should be approximately of the same resistance in each instrument, as well as the resistance of the receiver coils, but these conditions are not essential. Where several instruments are used on a single line, as on a party line, the ringer magnets and the winding of the generator armatures should be the same in all.

I have a threshing machine run by fourteen horses; could I attach a dynamo to the horse power and run a wire to a motor on the separator; and if so, what would be the loss and what size machine would be necessary? D. H. D.

The loss would probably be 40 per cent., including that of the gears. A machine of over 20 h.p. would therefore apparently be required, but it is very probable that this figure is too large. It would be well to write to the makers and inquire the horse power necessary for running the separator, which will give the size of the motor and consequently of the dynamo.

How can I connect up a battery of Samson cells to keep them from polarizing, and will 30 cells in series polarize as quickly as one cell or if the 30 are connected up in multiple? C. R. P.

This type of cell cannot be kept from polarizing by any system of connection, being of the open-circuit type. The polarization in any cell is directly proportional to the current flowing through it, so that if the current is small, the polarization proceeds slowly. The arrangement of the battery cannot be modified for a given case as implied, being fixed by the watts of energy required from it.

How is the hysteresis loss calculated? R. H. M.

If W are the watts loss per cubic centimeter of iron, N the number of reversals per second, and B the gausses or number of lines of force per square centimeter of section—that is, the flux intensity—then

$$W = K + N + B^{1.6} \times 10^{-7}$$

where $K = .002$ for best wrought iron, and .016 for cast iron. For direct current armatures, B is generally about 15,000, and for alternators about 7,000. Dividing the number of revolutions per second by half the number of poles gives N. For watts per cubic inch, multiply W by 16.4. For transformers B does not exceed 9,000, and N is the frequency.

How does the resistance of a voltmeter affect its reliability? H. L.

The voltmeter being in shunt with the circuit measured, the current will divide inversely as the resistances; consequently, if a voltmeter of low resistance is calibrated on a circuit of one resistance, and is used on a circuit of another, it may give an incorrect result because of the change in the ratio of resistances of the circuit, and also because of the additional drop introduced into the circuit by the current flowing through the voltmeter. In practice it is rare, however, that these conditions are encountered.

In making a Wimshurst machine I have had much trouble from glass discs cracking after being cemented on the hubs; how can this be remedied? R. L.

If the holes are bored in the disc so as not to start any cracks, none will develop subsequently. It is quite difficult to do this, however, as a small chip in the edge of the hole may suffice to start a crack. Plate glass should be used, and a piece of tough paper pasted on either side at the center of the plate; on this is drawn, with a pair of dividers, a circle representing the hole, which is then ground out with a brass tube of the proper size, using emery and oil. It is best to use a drill press or lathe for the operation, and to work from both sides of the glass.

1. Why is it difficult to maintain an arc in a magnetic field? 2. What is an equalizer and what is a compensator? 3. Is there any way in which a live circuit can be charged with static electricity, and if so, what effect would it have on the current flowing? E. E.

1. The magnetic field affects the electric arc in the same manner that it would affect a conductor carrying the same current, deflecting it when there is certain relation between the direction of the arc and the direction of the magnetic field. In one such relation the magnetic field would have no influence on the arc. 2. An equalizer is a conductor of the smallest practicable resistance used to connect together the brushes of the same sign on two or more direct-current machines running in parallel. A compensator is a voltmeter transformer whose windings can be adjusted so as to compensate for circuit drop. 3. If a circuit is entirely insulated, it may be charged statically whether a current is or is not flowing in it, and there will be no influence on the current flowing in the former case.

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Apparatus and Appliances

ANGULAR BIT STOCK.

In an article in this department in the March issue, the length of the Meister bit stock described was stated to be 22 ins. This was a typographical error, the length being 12 ins.

HIGH PRESSURE ALTERNATING CURRENT SWITCH.

In the operation of this switch the alternating current arc is rapidly extinguished between metal rolls or balls placed very close together, but the sehvice nit not suitable for use with continuous current.

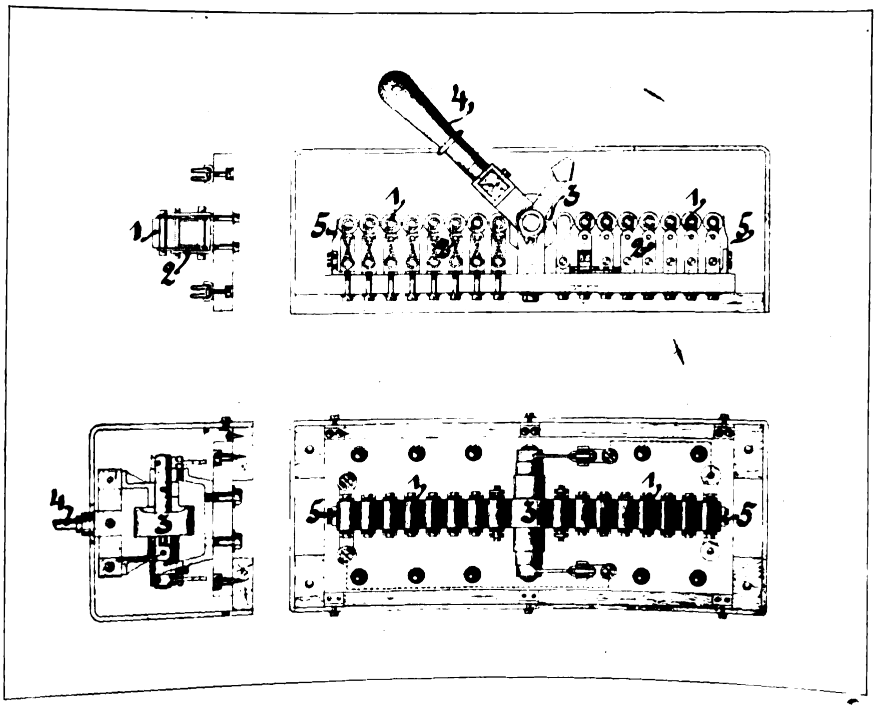
The principle of operation depends, first on the considerable cooling-off effect which the entire mass of the metal rolls exerts on the small arcs produced; and second, on the slight liability to oxydize possessed by the metallic fumes of the alloy which is used, in consequence of which the transitory resistance increases rapidly. Furthermore, in order that a switch in continual use may not cease its functions, the following conditions are imperative: First, that the rolls be rotated at every turn in such a way that the surfaces between which the arc is produced are shifted, in order to increase the cooling effect, and to change the surfaces which touch one another; second, the connecting-up in quick succession of a large number of such gaps, whereby the probability is assured that one of the many interruptions will take place at the moment when the amplitude of the current is approximately null.

These conditions are fulfilled in a simple manner by the switch constructed by Chief Engineer H. Muller of the Electricitäts Actiengesellschäft, late Schuckert & Co., of Nuremberg, which is illustrated herewith.

In this apparatus a continuous path for the current is formed by easily rotating rolls, 1, which are attached to plate springs, 2. The circuit is closed by turning down the lever, 4, whereby the rolls are pressed outward and against each other by means of the eccentric disc, 3. These rolls are released when the lever is raised, thus causing the circuit to be broken. The end rolls are met by powerful flat springs, so that when the other rolls are pressed together these are but slightly displaced. As will be seen without further explanation, all the rolls are caused to rotate when the circuit is opened or closed, and in consequence of this rotary motion, they turn regularly after each operation of the switch, causing new surfaces to be brought into contact. Furthermore, the rotary friction rubs off any oxide produced, and in consequence of these two circumstances the switch can be used for long periods without requiring repairs or renewal, which is a valuable quality in high pressure connections, owing to the danger involved in overhauling the same.

The sparking produced by a switch constructed on this principle is so slight, even in breaking the circuit of high pressure currents up to 6000 volts, that the apparatus can be erected in the immediate neighborhood of instruments of any kind. The arrangement described can also be employed as a multiple-switch. For powerful current it is advisable to place the apparatus in shunt with an ordinary switch (as shown in the cut), which insures for the continuous passage of current a connection as free from resistance as possible.

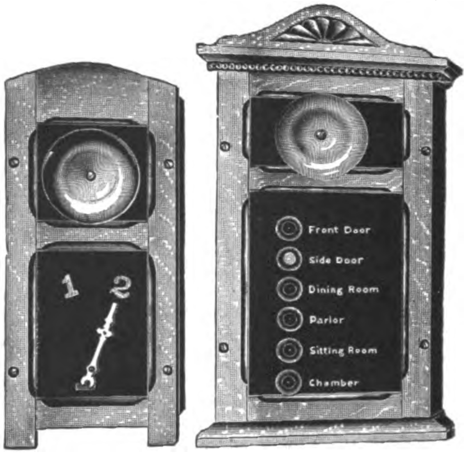
The experiments made during the last two years by the firm mentioned, as well as the regular use of this apparatus in the municipal plant in Nuremberg, and in many other installations, have, it is claimed, fully proved the excellence of its design. Furthermore in parallel connection the superiority of this apparatus has also been clearly established. Even with 150 amps. and 2000 volts the switch performs its functions with scarcely a sign of a spark.



HIGH PRESSURE ALTERNATING CURRENT SWITCH.

AUTOMATIC ANNUNCIATORS.

The accompanying cuts illustrate the "Ideal" automatic house and elevator annunciators. This type of annunciator is automatic in its action, it not being necessary to reset it after each call, as the last call is the only one showing and can be seen at a glance. These features, it is claimed, obviate the constant and violent hammering so often noticed in re-setting an annunciator. Another superior feature claimed for these annunciators is that by avoiding the above-mentioned annoyance the annunciators when once properly installed will not get out of adjustment, but will remain in perfect order. These annunciators are manufactured by the Heath Electric Company, 336 Grand River Avenue, Detroit, Mich.

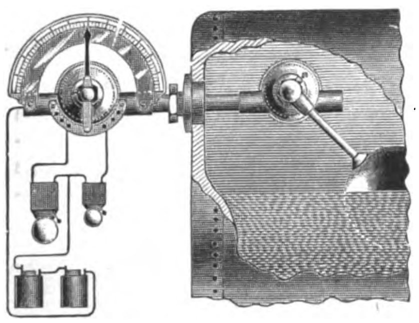


AUTOMATIC HOUSE AND ELEVATOR ANNUNCIATORS.

HIGH AND LOW WATER ALARM.

In the accompanying illustration Figs. 1 and 2 show a water column alarm attachment; that of Fig. 1, including try cocks, water and steam gages and water level indicators. The advantages claimed for this alarm are that no scale or other material can in any way interfere with its operation, the alarm being given by means of an electric bell. A number of signals may be placed in different parts of a factory or other building, each of which will sound when the water reaches a high or low limit in the boiler. The gage glass and dial serves as a check one upon the other. If for any reason the float should become filled with water or should collapse, the low water alarm would be sounded, thus indicating the derangement of the apparatus. There are no links or complicated mechanism to become locked by rust or scale, and no packing is used except for the gage cocks and glass, the stuffing-box through which the spindle passes being without packing.

The whole mechanism consists of a float and rod, which operate a spindle passing through the side of the casing of the umn, at the other end of which is a pointer carrying also a brush for making and breaking the electric circuit operating the alarm bells. Testing switches are placed in the circuit by means of which it can be determined at any moment if the apparatus is in good working order. The makers are the Hercules Float Works, Springfield, Mass.

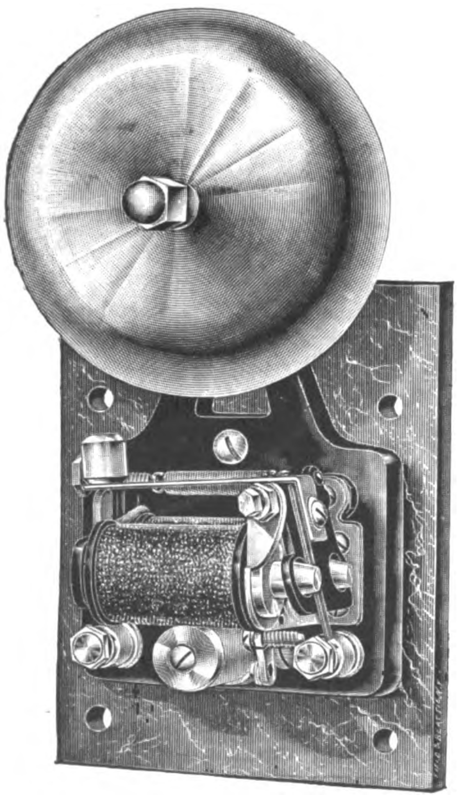


LOW WATER ALARM.

BELL FOR ELECTRIC LIGHT CIRCUITS.

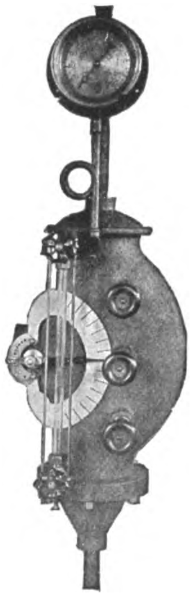
The need of a bell that may safely take current from electric light circuits has long been recognized, and the accompanying cut shows a type arranged for this class of work, though any other kinds of bells, electric or electro-mechanical, can be similarly fitted.

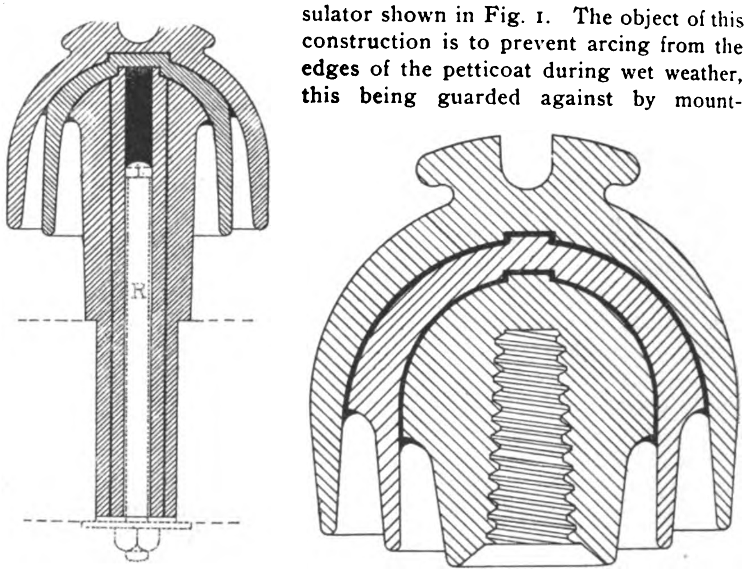
The style of bell shown is mounted on a marbleized slate base, and arranged to operate from circuits up to 500 volts. A special resistance is used, which will, it is claimed, neither melt nor burn, being placed in circuit with the bell. When the armature is attracted, the coils of the magnet are shunted, thus leaving the resistance in circuit, and thereby preventing sparking and burnt contacts. The resistance is so adjusted that at no time can more than one-sixth of an ampere pass through the coils.



BELL FOR ELECTRIC LIGHT CIRCUITS.

Edwards & Company, 144th Street and Fourth Avenue, New York, have originated the above type of bell, which they make in all the usual sizes.





FIGS. 1 AND 2.—HIGH VOLTAGE INSULATORS.

HIGH VOLTAGE INSULATORS.

In the article in the March issue on the Delta transmission plant, mention was made of the high voltage insulators used, of which we are now enabled to present an illustration. These insulators are of the "Boch" glazed and filled type, and are made in three parts of a uniform thickness, thus overcoming the danger in porcelain manufacture of cracks which are sure to occur where there is a thick part and a much thinner part to be dried and fired. Each of the three parts is thoroughly covered inside and out with a glazing, then fitted together, ready for the vitrified kiln, by being placed in the saggers upside down like an inverted bowl. A glazing material is then put into the joints, that is, into the annular channels between the petticoats.

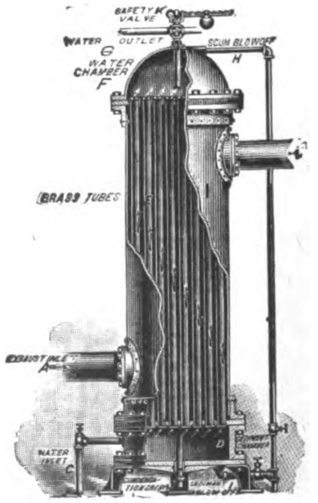
The parts thus put together and supplied with glazing material, are then placed in a kiln, in which, under great heat, the clay shrinks and becomes vitrified and the glazing melts and becomes of a glass-like character. The glaze which was put into the annular channels between the petticoats flows down into and fills all the spaces between the parts of the insulators. The result is that the three parts are firmly united to each other throughout by means of the glass-like glaze, thus, as will readily be seen, insuring both electrical and mechanical strength.

The six skins of glaze and the two solid walls of glaze or glass formed by this method of manufacture, give an insulator that will stand up under almost any voltage, no matter what the general conditions may be. The insulators used at Delta were, before shipping, subjected to a test of 50,000 volts by being placed in salt brine upside down with salt brine put into the third petticoat or pin hole, one pole being in the pan and the other in the testing pin hole.

Since writing the above another patent has been issued to Mr. Boch for the insulator shown in Fig. 1. The object of this construction is to prevent arcing from the edges of the petticoat during wet weather, this being guarded against by mounting the petticoat body on a porcelain post, which passes down through an opening in the wooden cross-arm or support, the metal fastening being secured in the porcelain post by suitably cement. Thus it will be seen that the metal pin is so well protected by the tubular post which sheaths it and passes down through the cross-arm, that leakage of current or arcing across from the petticoats to the pin (liable to occur on high potential circuits of present construction) is thereby entirely obviated, as the exposed end of the pin, its nut and washer on the under side of the cross-arm, are too far away from the conductor to give trouble.

FEED WATER HEATER.

In the feed water heater illustrated herewith there are three principal parts, namely, sediment chamber, heater proper and water chamber. The heat of the exhaust steam is rapidly absorbed by the water that passes through the brass tubes, attaining oftentimes a temperature as high as 210 degs., thereby leading to great economy in the coal consumption. The makers claim that this high efficiency is due to the radiating surface being in excess of

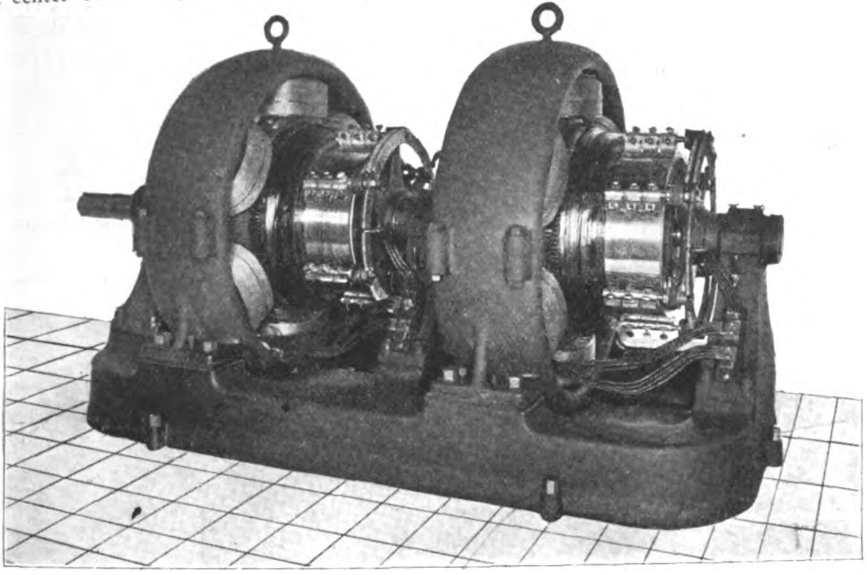


FEED WATER HEATER.

the absorbing surface by an amount equal to the difference of the area of the exterior and interior of the tubes.

The brass tubes are rigidly fixed in the bottom flange, but left free for motion with a steam-tight joint in the top flange to allow for expansion and contraction. The tubes are all straight, which facilitates easy cleaning and secures maximum strength, as bending of tubes always tends to weaken them. Proper provision is made for sediment and scum blow-off and exhaust condensation drip. The change of direction taken by the water immediately upon entering the heater favors precipitating impurities, which is further facilitated by the vertical direction maintained through the tubes. The water leaves the heater from the center of the top chamber free from impurities that are lighter than water, which rise to the top and are blown out.

The Bundy heater above described is manufactured by the A. A. Griffing Iron Company, 66 Center Street, New York.



THREE-WIRE GENERATING SET.

PORTABLE DESK TELEPHONE.

A desk telephone of new design has recently been placed on the market and is illustrated herewith. This instrument is especially arranged for intercommunicating systems of from three to fifteen stations, in business and manufacturing establishments.

PORTABLE DESK TELEPHONE.

An important feature is the entire absence of plugs, switches, or other contrivances for calling individual stations, there being used instead separate signaling keys directly on and in front of circular base, as shown in the illustration. The instrument is of handsome appearance, substantially constructed and the connections are simply and easily made. The manufacturers are the Allen-Hussey Company, 211-213 Randolph Street, Chicago, Ill., who make a specialty of interior and short line telephony.

SPECIAL MULTIPOLAR MACHINE.

The accompanying engraving illustrates a special generator of 150 k.w. capacity, just designed and built by the American Engine Company, for the Crookston Water Works at Crookston, Minn. The machine will be driven by a turbine shaft through a friction clutch coupling, running at 300 r.p.m., and will be used for supplying direct current to a three wire system.

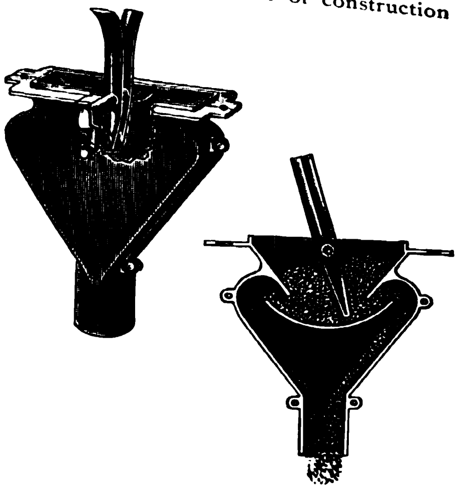
This machine is required to run at very low temperature and without any brush movement, and has been designed to meet the most exacting requirements otherwise. As in all the machines of the American Engine Company—both engines and dynamos—the symmetry and mechanical appearance are salient features.

AN IMPROVED SAND BOX.

The sand box illustrated herewith is made of bronze metal, and has an opening in the box, under which is a curved shelf. The ends of the shelf extend beyond and above the opening in the box, so that the sand cannot escape by gravity. A paddle is reciprocated above the shelf, and the movement of the paddle forces the sand in each direction alternately over the ends of the shelf to the feed spout which leads to the car track. Above the paddle are two fingers which stir the sand. The connecting rod passes forward to the car platform, and is operated by a pin and bell-crank lever, or by a hand lever.

The working parts are simple and the motions direct. The strokes of the foot or hand may follow each other so rapidly as to practically secure a continuous, but small, stream of sand, a decided advantage in hill climbing. It can be easily seen that waste is impossible in this box, as the sand flows only when the lever is in motion, and the quantity of sand is regulated.

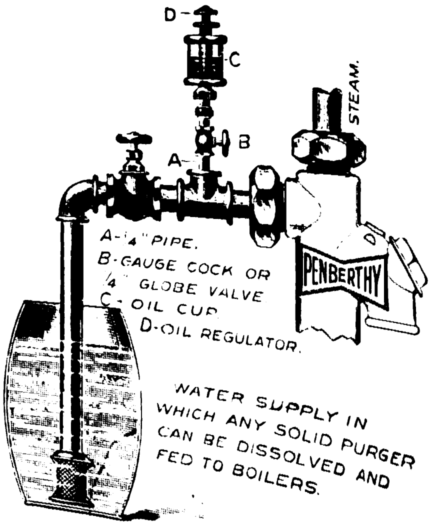
The hand hopper inside of the car and directly over the sand box, may be made of any form desired. If the space under the seats is inclosed, a square soap box or any other cheap form of construction may be employed. Small stones, or other small substances will not interfere with the operation of this box, but will pass freely through it. In fact, the company recommends coarse in preference to fine sand, even if it contains gravel stones as large as peas, as it is less likely to pack in the box. This sand box described is sold by the Electric Appliance Company, Chicago.



SAND BOX.

FEEDING PURGERS TO BOILER.

The accompanying cut shows an arrangement for feeding purgers to boilers, either from a barrel or from a cup or tank. When the purger is in the form of a powder it should be placed in a barrel and dissolved and fed as shown in the cut. In the case of kerosene oil or other liquid purgers, an ordinary oil cup can be attached, as shown, at a very small expense. A regulating cup is, however, not necessary, as any receptacle will answer so long as the valve "B," by which oil


D
C
B
A
STEAM.
A-¼" PIPE.
B-GAUGE COCK OR ¼" GLOBE VALVE
C-OIL CUP
D-OIL REGULATOR.
PENBERTHY
WATER SUPPLY IN WHICH ANY SOLID PURGER CAN BE DISSOLVED AND FED TO BOILERS.

BOILER PURGER FEEDER.

can be regulated, is tight. This attachment is applicable to the suction pipe of any injector, it being only necessary to have tight joints to prevent air getting into such pipe.

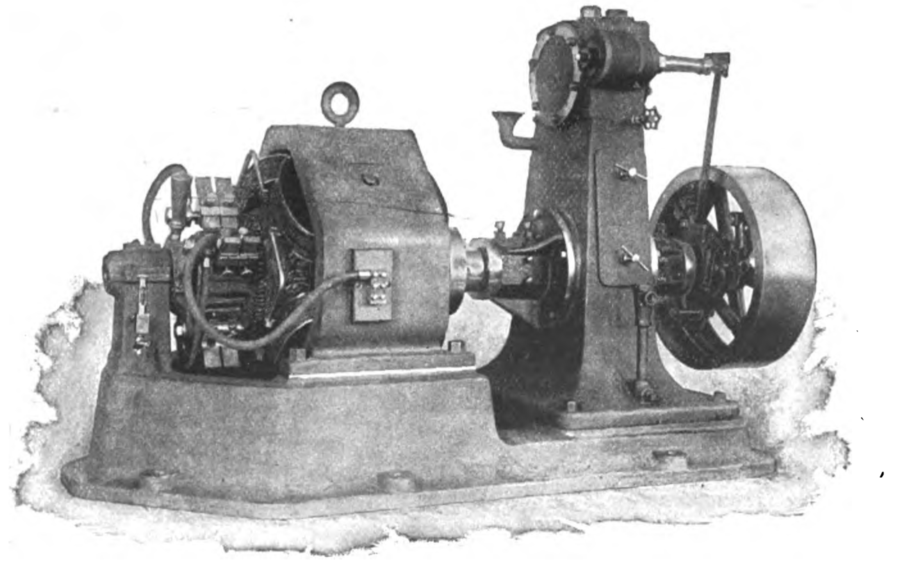
To operate, the valve "B" is closed, the injector is started, then the valve opened to the desired feed. The valve "B" is closed before stopping the injector.

The expense of the oil attachment outside of the cup, which is not necessary, will not exceed 50 cents. A short piece of large steam pipe reduced to ¼ in. will answer as well as the cup "C."

The Penberthy Injector Company, Detroit, Mich., to whom we are indebted for the information herein contained, states that it used kerosene oil for a while and nearly ruined its boiler, and adds: "It is bad—don't use it—but if you will use it, use the above device, which is public property and free for all. Our boilers are eight and ten years old respectively, and they are about as clean as the day they were put in. The boiler inspector of this city and Hartford insurance inspector will no doubt testify to this."

MARINE LIGHTING.

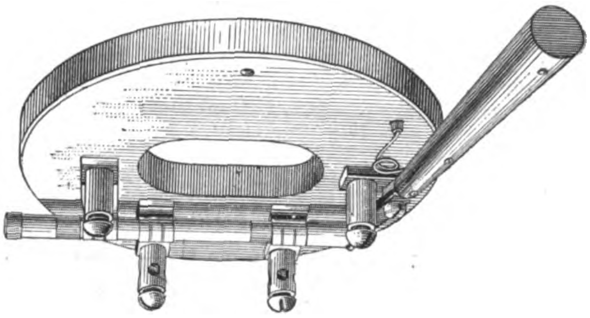
It is interesting to note that the lights used by the divers assisting in the investigation of the Board of Inquiry into the blowing up of the battleship "Maine," were furnished from a generating set consisting of a No. 5 Case engine direct coupled to a 7½ k.w. Bernard dynamo. Owing to the muddy condition of the water, light was absolutely necessary to assist the divers in their examination, and the set herewith illustrated, which is installed on the United States light-house tender "Mangrove," was in almost continuous use for this purpose.



MARINE GENERATING SET.

ARC LAMP HANGER BOARD.

The accompanying illustration shows a hanger board and cutout combined, the method of lamp suspension being such as to be suitable for lamps with terminals close together or wide apart or for lamps supported by a single eye at the center; the board is also well adapted for attaching to lamp hoods. The base is of slate, japanned black, and is made solid or with an oval hole in the center large enough to pass the stack of a single or double carbon lamp. The slide rod is actuated by an insulated handle controlled by a spring which throws the handle either side of the center.



ARC LAMP HANGER BOARD.

The handle is drilled for the insertion of a cord for operating it at a distance. It can also be operated by hand or with pole. The contacts are of phosphor bronze and all parts are either dipped or polished and lacquered, making a board of handsome appearance. The operation of the slide rod is first to shunt the lamp and then cut it in or out entirely and absolutely without sparking. The above board and cutout, known as the "K. & W. Hanger Board and Absolute Cutout," is made by the K. & W. Company, Pittsfield, Mass.

ELECTRIC HEATING IRONS.

The electric soldering iron shown in Fig. 1 is made especially for telephone work—either for use in telephone exchanges or in the manufacture of switchboards. It is 11 ins. long, weighs but 15 ozs., and consumes 90 watts of energy when in operation. The iron shown in Fig. 2 is made especially for tinsmith's work, and is now largely employed in packing houses throughout the country. Fig. 3 shows an electric curling-iron stand, having a base 3½ ins. x 3½ ins., a height of 6 ins., and consuming 90 watts. That is, if run for an entire hour it would cost less than two cents at the highest rate charged for electric current. The above described heaters are made by the American Electrical Heater Company, 197 River Street, Detroit, Mich.

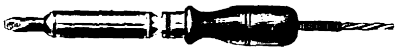


FIG 1.—TELEPHONE SOLDERING IRON.

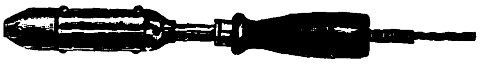


FIG. 2.—TINSMITH SOLDERING IRON.

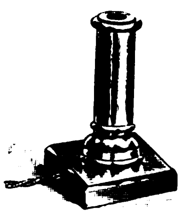
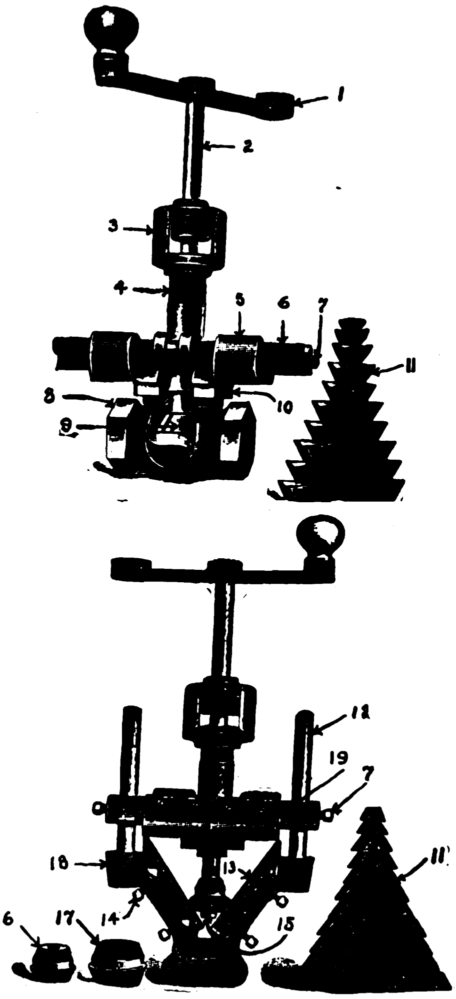


FIG. 3.—ELECTRIC CURLING IRON HEATER.

VALVE RESEATING MACHINE.

The value of a practical and reliable valve-reseating machine is now recognized by engineers everywhere, and the type shown herewith can be attached to all makes of valves regardless of the size of thread or diameter of opening in the valve hood. The valve seat is cut with reversible self-clearing tools, which may be ground when dull, which is the only method of invariably obtaining a true seat. The attaching device consists of a block-chuck with gibs placed between the two



VALVE RESEATING MACHINE.

blocks, and the bar to take up the slack. Upon the under side of the blocks is a series of parallel segment-shaped steps, the curved face of each step being threaded to correspond with the threads of valve casings with which the steps are designed to engage.

The screw rod opens or closes the chuck jaws. The cutters for dressing a taper-seated valve are on the inner opposite edges of a V-shaped bar, being attached to it by means of screws that pass through slots in the bar, and thus permit of a rigid angular adjustment of the cutters. It is to be noted that the cutters or blades, by being located on the sides of said bar, have their cutting edges presented on lines tangential and not radial to the axis of the valve being ground. The result of this is that the cutting edges do not catch or unduly bite into the valve, and hence objectionable chattering is avoided and a smooth, easy and free cut is produced.

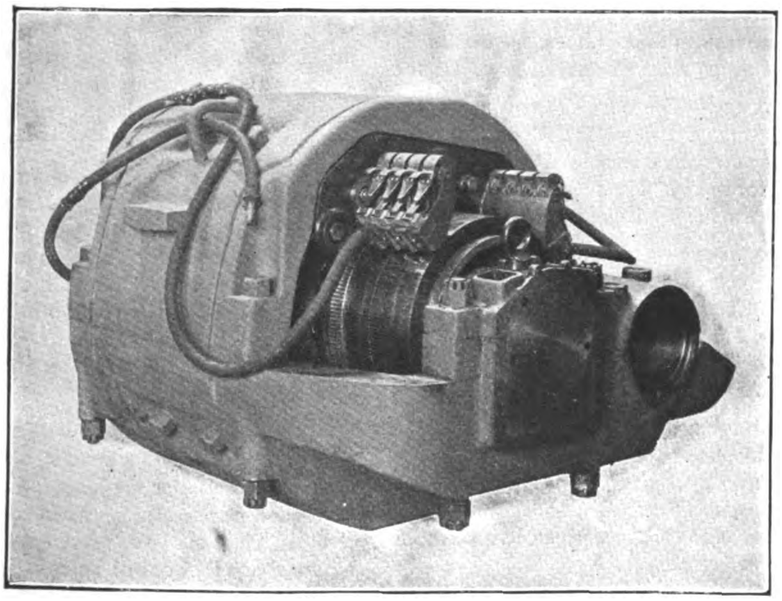
The machine, which is known as the Benton Valve Reseating Machine, is made for all sizes of valves of either flat or taper seat up to 12 ins. in diameter, and is sold by Wendell & MacDuffie, 26 Cortlandt Street, New York, and 53 State Street, Boston.

WALKER ELEVATED RAILWAY MOTOR.

In our last issue a brief description appeared of the 80-h.p. Walker motor, to be used on the Brooklyn Elevated Railway, an illustration of which appears herewith.

The motors were designed by Mr. S. H. Short, of the Walker Company, especially for elevated railway service, and will be built upon the lines of generators. The frame is cast entirely from the best quality of soft steel, the magnetic ring being circular in form and containing four laminated field magnets with pole shoes. Each one of the magnets is wound with bar copper, insulated with asbestos, forming a perfect fireproof coil. The motor frame is divided on a horizontal plane, with the axle bearings and armature bearings carrying the lower half, so that the lower half is supported by the axle and the truck bolster, leaving the upper half of the magnetic frame free to be removed from above, exposing the armature and the whole interior of the motor. The armature bearings are held in pockets cast in the lower frame of the machine, and can be lifted out with the armature from above by means of an overhead crane. The axle is arranged to pass through a tubular cavity cast in the motor frame, so that any oil which may ooze from the axle bearings will run into this cavity and back into the oil wells, with no possibility of leaking into the interior of the motor. The armature bearings are also arranged in solid cast iron boxes containing brasses, and arranged so that the oil which lubricates them returns immediately to the oil wells and does not creep out along the shaft and onto the motor shell. The armature is hollow and provided with air ducts running radially through the laminations to insure perfect ventilation. The winding is made from bar copper, with only one turn for each commutator bar. The modern practice of very few slots is used in the armature, with four inductors in each slot, the insulation being entirely of mica, rendering it also fireproof.

The frame of the motor is left practically open for complete ventilation, so that the heated air on the interior of the motor can escape freely, thereby increasing the capacity for the motor for sudden and heavy over-loads. The motor is so designed that it will not spark under any condition of load, and can take currents two or three times the normal current of the motor without damage to any part of the machine.


WALKER ELEVATED RAILWAY MOTOR.

The brush holders are provided with four brushes each, held firmly in movable brass and bronze boxes, each box being connected directly with the terminals of the brush holders by means of flexible cables, so that the current is not permitted to pass through any moving joints, which would cause heating. The commutator bars are insulated from the shell by means of continuous molded insulation made from pure mica. The commutator bars are made from drop forged copper of the purest quality. The current density in the brushes is about 35 amps. per sq. in., or about the same as is used on the latest types of generators. These machines are so designed that they will run in practice as cool as ordinary generators in the station. The carrying capacity of the copper used in the machine is very great, the resistance being reduced to a minimum, so that they are very efficient for very heavy overloads —a necessary requirement for motors which have to start heavy trains at short intervals of time.

The motors are also provided with armature covers, which can be used to close the motors up tightly during the winter weather, when they will be required to run through snow.

These machines are built especially for elevated railway work, although they can be applied to heavy surface railways, such as branch lines of steam railways, many of which are now experimenting in this line. A large number of these motors have also been ordered by the Metropolitan and West Side elevated railways in Chicago, where they are to be used in operating four-car trains. The Brooklyn motors are, however, of 80 h.p. each, while the Metropolitan motors are of 150 h.p. each. The wheels used are 33 ins. in diameter, with steel tires.

PERSONAL.

MR. I. FUJIOKA, of Tokio, Japan, has arrived in the United States, where he will spend some time before sailing for Europe. Mr. Fujioka is the leading Japanese electrical engineer and electrical manufacturer in Japan, his apparatus being noted for excellent design and mechanical execution.

M. GEORGE PELLISSIER, editor of *L'Eclairage Electrique* and a prominent French electrical engineer, recently arrived in New York, on his way to Auckland, New Zealand, in the interest of a Parisian syndicate to examine some electric railway and lighting properties.

PROF. MASSASHI NAMBA, professor of electrical engineering at the University of Kioto, Japan, is on a visit to the United States in order to inspect the latest electrical developments. Prof. Namba began his electrical studies under Prof. Mendenhall, at the Tokio University, and completed them under Prof. Mascart, at Paris, having for a time been an assistant in the laboratory of each. The University of Kioto has but recently been founded, a part of the Chinese indemnity fund having been set aside for that purpose.

MR. E. J. WESSELS is meeting with much success with his new venture, the *Universe*, an illustrated newspaper for the young. In these days of yellow journalism and the reading habit among the young folks, the time was ripe for a well-written and well-edited publication, which parents can safely place in the hands of their children, to satisfy their desire to know what is going on in the world. The *Universe* (which is published at 96 Fifth Avenue, New York), is most satisfactorily supplying this need.

Mr. Frankland Jannus has removed from Washington and taken offices in the Havemeyer Building, New York. Mr. Jannus has had sixteen years' experience with patent cases of all kinds at Washington, and will continue in New York his practice in all matters relating to patent interests.

Mr. Geo. T. Hanchett, electrical engineer, has removed to 123 Liberty Street, New York, where he has every facility for preparing engineering drawings and tracings on short notice. Mr. Hanchett has associated with him competent draftsmen and mechanics, which render his facilities for performing engineering work very complete, every means being at hand for the design and actual construction of electrical machinery and models. A specialty will also be made of perfecting inventions and apparatus, so that they can be manufactured in excellent quality at a minimum cost; and of the design of special machinery to accomplish certain work.

NEW BOOKS.

Elements of Electro-Chemistry Treated Experimentally. By D. Robert Lupke. Translated by M. M. Pattison Muir. Philadelphia: J. B. Lippincott Company. 223 pages, 54 illustrations. Price, $2.50.

This work treats, in as simple a form as the subject will permit, of the modern science of electro-chemistry as developed by Nernst, Ostwald and other German electro-chemists, and of which until recently English readers have had little knowledge. Although the main purpose of the book is to set forth the purely scientific aspects of electro-chemistry, the practical sides of the subject have not been left altogether unnoticed, technical electro-chemical processes, such as electro-metallurgy, receiving attention.

Universal Electrical Directory for 1898. By J. A. Berly. London: H. Alabaster, Gatehouse & Company. Large octavo, 1180 pages. Price, 6 shillings.

The seventeenth annual volume of the "Red Book" has been increased by 70 pages, making in all about 1100 pages of directory matter. The entire world is covered, the American section, for instance, containing no less than 4080 distinct names and addresses, the total number of names of firms and individuals in the volume being 23,794. Among new matter are additions to the financial information, and telegraphic addresses and local telephone addresses in the British section.

Model Engines and Small Boats. By Nevil Monroe Hopkins. New York: D. Van Nostrand Company. 74 pages, 50 illustrations. Price, $1.25.

The amateur with a taste for mechanics will find this a most interesting work, giving, as it does, clear instructions, accompanied with excellent engravings of detail parts, for making an oscillating and slide-valve engine and a small boiler. By the system of the writer, no patterns or castings are required for constructing small engine cylinders, and the boilers may be made without the use of special tools. A final chapter is on elementary boat design, and a system of hull construction, using wooden ribs in combination with cardboard plating, which is stated to give entire satisfaction under trying circumstances.

Mechanical Draft. A Practical Treatise. Boston: B. F. Sturtevant Company. 385 pages, 109 illustrations.

That this handsome volume is issued primarily as a commercial publication is only evident from the illustrations of apparatus, which are all by one manufacturer. Otherwise the book is what it purports to be—a practical technical treatise on mechanical draft, and as such is better adapted for the use of the engineer than any other work on the same subject published. The titles of the various chapters are as follows: Water.—Steam.—Combustion.—Fuel.—Efficiency of Fuels.—Efficiency of Steam Boilers.—Rate of Combustion.—Draft.—Chimney Draft.—Mechanical Draft.—Advantages of Mechanical Draft.—Fans for Mechanical Draft.—Applications of Fans for Mechanical Draft.

TRADE PUBLICATIONS.

Generators and Motors.—Jas. Clark & Co., Louisville, Ky., in a well gotten up pamphlet illustrate and describe the "Willey" generators and motors, all of the details of which are separately shown in cuts.

Switches.—The O. S. Platt Manufacturing Company, Bridgeport, Conn., have issued a new catalogue, in which all of the many forms of "New England" switches are shown in good engravings.

Resistances.—Carbon resistances are the subject of a pamphlet issued by the Raster Carbon Rheostat Company, 414 Ashland Block, Chicago, in which the reader will find something of interest on the practical use of carbon as a resistance.

Armorite.—An interesting pamphlet comes from the Armorite Interior Conduit Company, Pittsburgh, Pa., in which the processes used in the manufacture of armorite conduit are described, with accompanying illustrations.

Gas Engines.—The New Era Iron Works, Dayton, Ohio, have issued a folder containing some excellent illustrations of the New Era gas and gasoline engine and a number of flattering testimonials to the excellence of this standard machine.

Fan Motors.—E. B. Latham & Co., 136 Liberty Street, New York, in a pamphlet devoted to fan motors, illustrate and describe a full line of these indispensable conveniences for the summer for both direct and alternating current.

Tuerk Fans.—In an extremely fine specimen of the printers' art the Hunter Fan & Motor Company, Fulton, N. Y., illustrate the 1898 models of the Tuerk ceiling electric fan. A prospective maker of a catalogue will do well to get a copy of this little brochure as a guide for his printer.

Friction and Lubrication.—The engineer will find in a recent publication of the Joseph Dixon Crucible Company, Jersey City, N. J., entitled "Friction and Lubrication," a concise and well-written treatise on the practical aspects of these subjects, including selection and uses.

Telephones.—The Central Telephone Company, 1123 Pine Street, St. Louis, in the 1898 edition of its catalogue illustrates and describes the various types of telephones, magnets, etc., of its manufacture, as well as a complete line of telephone supplies.

Electric Heating.—Electric soldering irons, laundry irons, tailors' irons, curling-iron heaters, electric heating discs, etc., form the subject of a catalogue issued by the American Electrical Heater Company, Detroit, Mich. The practical form of all the apparatus shown is evident from the cuts.

A Modern Engine.—In this day of handsome trade publications to say that one is the handsomest specimen of current issue means much. This remark, however, applies to a recent circular issued by the Ball Engine Company, Erie, Pa., entitled "A Modern Engine," which will well repay the cost of a postage stamp to obtain.

Shade Lamps.—The Electric Appliance Company, Chicago, in a handsomely executed little pamphlet, illustrates a variety of shade lamps for the office and family circle, including desk and typewriter lamps. Among these are the Espersen adjustable lamp shade, the Klemm portable desk lamp and the Dale bracket lamp.

Electrical Insulation.—In a 48-page pamphlet the H. W. Johns Manufacturing Company illustrate over 150 different kinds of molded mica and vulcabeston electrical material, including trolley line insulators, weather-proof sockets, controller parts, field spools, bushings, etc. The final pages are devoted to "H. W. J." car heaters and electrotherms.

Walker Circulars.—Walker circulars 1066-1069 are on the electric plant of the Astoria Hotel, electric locomotives, boosters and electric railway generators, respectively. That on boosters very clearly explains the principles of an apparatus which is entering largely into use, and every part of Walker generators is illustrated in detail in circular No. 1069.

Lundell Fan Motors.—The Sprague Electric Company, 20 Broad Street, New York, has issued a handsome catalogue of 1898 models of Lundell motors, the cover being particularly artistic in design. One of the features of the catalogue consists of excellent Bartlett wood cuts, showing every detail of the Lundell motor, even the most minute.

Special Incandescent Lamps.—The General Electric Company, in a handsome

44-page pamphlet, illustrates and describes lines of candelabra, special series, and battery lamps. Some of the first mentioned are in especially handsome shapes. The two latter classes comprise lamps for decoration signs and for every purpose to which small lamps have been put in the trades and arts.

WAGNER BULLETINS.—Bulletins 9A and 10 of the Wagner Electric Manufacturing Company, St. Louis, are on type G and type F transformers, respectively. All of the details of the transformers are illustrated and much technical information included, such as tables of efficiencies, notes on the aging of iron and testing of transformers, curves, of regulation, core losses, efficiency, etc.

A JAPANESE TRADE CATALOGUE.—We have received from Charles Wirt, 1028 Filbert Street, Philadelphia, a copy of pamphlet printed for a Japanese company with an unpronounceable name, which is intended for distribution in the "Land of the Rising Sun." This is one of the straws showing which way the wind blows as concerns the advancement of the Japanese in the industrial arts.

STEAM SPECIALTIES.—It is seldom we see a catalogue so full of practical information as one recently issued by the A. A. Griffing Iron Company, 66 Centre Street, New York. While its ostensible object is to bring out the merits of Bundy apparatus, the information it contains on steam working gives the pamphlet the character of a technical treatise on the subject, written moreover from the standpoint of the working engineer.

HYDRAULIC FITTINGS AND FLANGES.—Thorpe, Platt & Company, 97 Cedar Street, New York, are sending out a pamphlet issued by the Tight-Joint Company, on high pressure air and hydraulic fittings and flanges, which give about fifty pages of useful technical information on the design of hydraulic plants and hydraulic pressure transmission. Many tables are included, and formulas are given for calculations of hydraulic detail.

INCANDESCENT LAMPS.—The General Electric Company, in view of the large number of applications made for information, which is embodied in the second part of its recently issued Edison Incandescent Lamp Catalogue, has published this information in a separate 16-page pamphlet of small octavo form. This information is of value to all users of incandescent lamps, and the General Electric Company will be pleased to supply copies of the pamphlet on application.

ELECTRIC GAS LIGHTING.—In a 136-page catalogue, the Electric Gas Lighting Company, 195 Devonshire Street, Boston, illustrates and describes every variety of electric gas lighting devices, and a full line of electrical house goods. Several handsome inset sheets in colors show a new type of candle burner attachment, the Samson battery and the Nosmas battery. The descriptions of apparatus are particularly well gotten up, the catalogue in this respect answering the purpose of a technical treatise on electrical house goods.

GEARS.—Steel gears and pinions form the subject of a small and artistic pamphlet, well illustrated and printed, issued from the press of the General Electric Company, under the title, "A Modern Gear Plant." It contains a description of the extensive plant that the company has established at the river works at Lynn, for the exclusive manufacture of steel gears and pinions, which is equipped throughout with the most modern machinery. This pamphlet will be sent on application to any of the company's sales offices, one of which is found in every large city in the United States.

CONTRACTORS' HANDBOOK.—The Montauk Multiphase Cable Company, 100 Broadway, has issued a handbook of much value to electrical engineers and contractors, consisting of a compilation of insurance statistics, giving the specific causes of fires over a period of thirty years, and the percentage for each cause. As the multiphase cable is a continuous fire-alarm, thus affording almost perfect protection against fire-hazard, the data of the book will greatly assist dealers in showing its value to prospective purchasers through reference to the figures showing the hazard to which their property is exposed without such protection.

COMMUTATOR BARS.—The Forest City Company, in a large page catalogue, illustrates to scale some scores of commutator bars, including not only those in general use, but bars for machines no longer manufactured. The "Protected" rail bond is also shown in excellent illustrations.

ELECTRIC LIGHT AND POWER SPECIALTIES.—Zimdars & Hunt, 127 Fifth Avenue, New York, in a large page catalogue with a striking cover, give a number of illustrations of the automatic switch and motor starters of their manufacture, the illustrations being made from photographs of the various articles themselves, taken just previous to the printing of the catalogue. In addition to the excellent half-tone engravings, there are others giving diagrams of connections.

FAN MOTORS.—The Western Electric Company, Chicago and New York, has issued a handsome 36-page illustrated fan-motor catalogue, printed in two colors and substantially bound in a neat and artistic cover. Every type of fan-desk, column, bracket and ceiling, is illustrated and described, both for direct and alternating currents. Detailed illustrations are given of a direct current desk and ceiling fan, and an alternating-current fan, showing all of the working parts. A column fan is shown which is particularly adapted for restaurants, soda-water fountains, drug stores, ice cream parlors and saloons, consisting of a fan somewhat similar to a ceiling fan, but mounted on the top of a column, at the base of which is a red birch table, 4 ft. in diameter. Battery fans take up three pages, and a complete list is given of fan accessories, such as flexible cord, attachment plugs, receptacles, etc.

BUSINESS NEWS.

INCLOSED ARC LAMPS FOR THE NAVY.—The Buckeye Electric Company, Cleveland, Ohio, has received from the Navy Department a large rush order for Jandus inclosed arc lamps.

THE D. A. KUSEL MANUFACTURING & ELECTRIC COMPANY, 1110 Pine Street, St. Louis, reports the telephone business in a very flourishing condition, and states that it is at present in receipt of orders which will keep the entire factory force rushed for some weeks to come.

THE WALKER COMPANY has recently secured a very handsome and commodious suite of offices on the sixteenth floor of the Commercial Cable Building, 18-20 Broad Street, New York. The suite includes a private hall, general offices, private offices for the officials of the company and all the latest conveniences for the modern transaction of business.

PROPOSALS WANTED.—The City of Columbus, Ohio, returned unopened the proposals that were to have been considered March 24, for furnishing the machinery, lamps and pole line for a municipal plant, and have invited new ones, to be opened April 13. Further information may be obtained by addressing James A. Fanning, clerk.

STORAGE BATTERIES.—The Electric Storage Battery Company, of Philadelphia, in its annual report, states that for the year ending December 31, 1897, the sales amounted to $1,026,925, against $572,281 for 1896, or an increase of $454,644. The net profits for 1897 were $340,008, and for 1896, $148,799, showing an increase of $191,209.

THE WARREN-MEDBERY COMPANY, of Sandy Hill, N. Y., has been incorporated for the manufacture of electrical supplies, with a capital of $25,000. The directors are Horace J. Medbery and S. C. Medbery, of Ballston Spa, N. Y.; H. B. Warren, of Yonkers, and W. H. Cunningham, H. E. Tidmarsh, Lincoln Paris and G. W. Wait, of Sandy Hill.

TELEPHONES.—The Stromberg-Carlson Telephone Manufacturing Company, Chicago, reports that it has just taken a contract for the complete installation of the Farmer's Mutual Telephone System, of Henry County, Ill. This equipment will consist of about 200 toll line instruments and will be, without doubt, one of the largest farmers' lines ever equipped.

SAFETY CONDUIT.—L. A. Chase & Company, Boston, are the selling agents of the new type of conduit made by the Safety Conduit Company, of Rankin Station, Pa. By a new process of manufacture, the interior surface of ordinary gas-pipe is rendered entirely smooth, so that under no circumstances can the insulation of wires be injured when drawn in.

DIRECT CONNECTED UNITS.—The New

Britain Machine Company, New Britain, Conn., successor to the J. T. Case Engine Company, is running overtime in order to keep up with their orders for engines to be used with direct connected generating sets. This company makes a specialty of sizes from 2½ to 25 h.p., nothing larger than the latter being constructed.

Westinghouse, Church, Kerr & Co. are to supply a complete equipment for a new power house of the Detroit, Ypsilanti & Ann Arbor Railway, consisting of five Westinghouse generators of 225-k.w. each, direct-connected to Westinghouse compound condensing engines; Babcock & Wilcox boilers, Roney mechanical stokers, economizers, apparatus for mechanical draft, etc.

Motors for the Navy.—The Bullock Electric Manufacturing Company, of Cincinnati, Ohio, is supplying a number of motors to the New York navy-yard, for operating drills and other large machinery in the construction shops. Owing to the present activity in naval matters, rush orders were given by the Government to complete the machines at the earliest possible moment.

The K. & W. Company, Pittsfield, Mass., has increased its capital stock, the additional capital to be used for the enlarging of its plant for the manufacture of Hardy incandescent lamps. The demand for the Hardy incandescent lamp has been both rapidly and steadily increasing, as has also the demand for the K. & W. new absolute cut-out hanger board and the K. & W. composite dynamo brush.

Electric Conduits.—The Safety Conduit Company, of Rankin Station, Pa., advise us that their "Loricated" electric conduits will be installed in the new U. S. Appraisers' warehouse, corner Greenwich and Christopher Streets, New York, and also in the Prudential Building, Atlanta, Ga. The former building will require in the neighborhood of 30,000 ft., the latter building over 50,000 ft. of iron armored conduit.

The Triumph Electric Company, Cincinnati, Ohio, made the following sales between March 1 and 15: Motors, one each of 67, 30, 7½ and 1 h.p.; five of 5 h.p. and two of 2 h.p.; generators, one each of 30, 15, and ¾ k.w.; two of 100 k.w. and two of 3 k.w.; elevator motors and controllers, one of 5 h.p., and three of 10 h.p. Also, a motor-generator of 4 h.p., a cloth cutter and a marble switchboard. This company booked 95 orders the first ten weeks of the year.

A St. Louis Office Building.—The Commerce Realty Company is erecting a large mercantile building at the corner of Ninth and Tenth Streets, St. Louis, which will have a very complete electrical equipment. The plant will consist of three 150 h.p. boilers, with down-draft furnace, two 300 h.p. Hoppes feed-water heaters, three compound Weston Imperial engines of 120 h.p. each, direct connected to three 75 k.w. General Electric generators. There will also be two passenger and six freight Sprague electric elevators. Bryan & Humphreys are the consulting engineers.

The Keystone Electrical Instrument Company, of Philadelphia, has appointed Mr. W. R. Garton, 414 Ashland Block, Chicago, Ill., its Western representative, with headquarters as above. This change means that the Keystone Company is out for all the Western business in sight, and with a representative of Mr. Garton's large acquaintance and well-known business energy, largely increased sales of its instruments in his district will result. Since the first of the year the company has had its force working day and night to keep pace with its orders, and is now preparing to largely increase its present facilities.

The Harrisburg Foundry & Machine Works has secured the services of W. R. Fleming, of the firm of W. R. Fleming & Company, of New York, Boston and Philadelphia, as vice-president and general manager, and will shortly make a considerable increase in its facilities for manufacturing automatic engines for electric service. It is intended to add several new lines of engines, so as to broadly cover the whole field of steam engine practice. It is also understood that the company will rebuild its entire plant upon a plan and scope which will place it in a superior condition for the manufacturing of its machinery, which has become so well known throughout the country.

The Central Telephone & Electric Company, 1123 Pine Street, St. Louis, reports that it is kept hustling to fill its orders. This firm is just installing a complete exchange at Baton Rouge, La., which will consist of 150 instruments to start with, and ultimately many more, as subscribers are still coming in. The satisfaction given by the instruments of this concern has been the means of rapidly extending its business, and the reputation it has gained for first-class superior goods is a permanent assurance to the purchaser that he will secure from this company the most up-to-date and perfect instruments obtainable.

The Rochester Electric Motor Company, Rochester, N. Y., has changed its management, the present officers being F. C. Kimmel, president, and Edw. F. Davidson, secretary and treasurer; P. T. McDonald remaining as superintendent. The works have been moved into larger quarters at the corner of Mill and Platt Streets, where with better facilities the growing demand for Rochester dynamos and motors may be more promptly filled.

Ball Engines.—On account of the great demands for its engines for electric light and power purposes, the works of the Ball Engine Company, Erie, Pa., builders of the Ball engine, have been operated night and day since September last.

Voltage Regulators.—The Alma (Mich.) Electric Light & Power Company has just placed an order with the Belknap Motor Company, of Portland, Maine, for a Chapman voltage regulator for a 60-k.w. alternator. The Warren (Pa.) Electric Light Company has just placed an order for a regulator for a 120-k.w. alternator, and the Milton (N.H.) Electric Light Company, one for a 100-k.w. alternator. The Belknap Motor Company has engaged space for an exhibit at the Electrical Exhibition to be opened in May at Madison Square Garden, New York City, where will be shown a line of Chapman voltage regulators and other electrical machinery. It also contemplates having an exhibit at the Paris Exposition in 1900.

The Metropolitan Electric Construction Company is now doing all of the installation work of the Sprague Electric Company, an arrangement to that effect having been recently closed. The announcement was made in a striking two-color circular by the Sprague Company, in which circular it was pointed out that the Construction Company would not only contract for installation and maintenance of Sprague machinery, but of any other machinery as well. The offices of the Construction Company, as well as those of the Sprague Company, are in the Commercial Cable Building. The officers are W. D. McQuesten, president and general manager, and Mr. Wallace E. Carver, treasurer.

Self-Setting Annunciator.—The advantages of a self-setting annunciator which is not subjected to constant and violent hammering in resetting, and hence does not get out of adjustment, are described in the circular catalogue issued by the Heath Electric Company, 335 Grand River Avenue, Detroit, Mich. This company also manufactures the "Ideal" automatic annunciator for house use. This annunciator is also automatic in resetting, and as the last call is the only one showing, this feature makes it one of the most convenient and desirable annunciators in use. The Heath Electric Company reports a very brisk demand from the supply trade for house, elevator and two-way annunciators and also for burglar alarms.

Mica Insulation.—The Mica Insulator Company, whose offices are at New York and Chicago, with a branch at London, England, recently received from one of the large builders of electrical machinery orders for over 5000 "Micanite" segments of a large pattern (many of which were more than 17 ins. in length); and from another leading manufacturer of electrical apparatus an order for 2000 segments; also, from one of the leading motor builders an order for 26,000 segments. Such orders would seem to bear out the claim of the company, that its segments are softer and wear down more evenly than mica segments. A sample set of segments for any one of the smaller machines will be furnished free of expense to electrical manufacturers or repair concerns who may wish to personally demonstrate their value.

The Duplex Manufacturing & Electric Company, 84 Adams Street, Chicago, has just placed a large number of its Duplex wire lamp guards for incandescent lamps in the stations and stairways of the Union Loop, Chicago. This guard is meeting with much favor, and is being purchased in large quantities by such companies as the Boston and Maine Railroad, Southern Pacific Railroad, The Pullman Company, Chicago, Rock Island, Pacific Railroad, Union Stock Yards and by factories and mills generally. Mr. L. M. Cole, president of this company, states that they are being favored with very large orders, and that the Duplex guard has proven itself a winner wherever used.

The Sprague Electric Company.—The organization of the Sprague Electric Company, which our readers well know was formed by the consolidation of the Interior Conduit & Insulation Company and the Sprague Electric Elevator Company, is being rapidly perfected. The offices of the company now occupy practically the whole of three floors in the Commercial Cable Building. The company recently secured a suit of rooms in the Marquette Building, Chicago, which will be in charge of Mr. Millard B. Kitt and Mr. E. B. Kittle, long identified with the company. Well-known electrical men and houses are being rapidly secured to represent the Sprague Company in various sections of the country, and the organization bids fair to be a remarkably strong one in every way.

The M. B. Wheeler Electric Company, 99 Ottawa Street, Grand Rapids, Mich., have just been incorporated for $25,000, under the above name. This company was formerly located at 25 Fountain Street, Grand Rapids, under the firm name of M. B. Wheeler & Company. The officials of the new company are A. O. Wheeler, president; S. D. Kopf, vice-president; M. B. Wheeler, secretary and general manager, and F. I. Cruse, treasurer. This concern has just finished the installation of 220 interior telephones in the recently remodeled Sherman House, Chicago. It is also doing the entire wiring for the mammoth factory of the Bissel Carpet Sweeper Company, of Grand Rapids, and also a complete installation for H. Leonard & Sons' wholesale house, in the same city, besides many minor installations throughout the State. Mr. A. B. Smith, who has had over fifteen years experience in the telephone business, a portion of which time he spent with the Bell Telephone Company, will give his personal attention to the telephone department of the above concern.

Rope and Bond Insulating Paper.—The Mica Insulator Company, of New York, Chicago and London, announces that it has recently made an addition to its already extensive line of oiled cloth and paper insulations, and is now prepared to furnish "M-I-C Compound" rope and and bond paper. This line of insulation is made from rope and bond paper treated with two baked coatings of M-I-C compound. The rope paper is furnished in sheets 1 yd. wide, 2 yds. long and packed between sheets of plain paper. The average break-down test is 739 volts per mil, the thickness being 4½ mils. The bond paper is furnished in sheets 19 ins. x 24 ins. and 22 ins. x 34 ins., the average break-down test being 859 volts per mil, the thickness being 5 mils. The company will be pleased to send samples to electrical manufacturers, street railways or lighting stations upon application.

A Special Bundy Separator.—The A. A. Griffing Iron Company, Jersey City, N. J., has just completed and forwarded to James Rees & Sons, Pittsburgh, Pa., a special Bundy separator for removing oil from ammonia gas. While the Bundy separators are regularly made for work of this kind, in this particular case the requirements were a trifle unusual, as the working pressure is 500 lbs. to the square inch. The separator is ordinarily strengthened and reinforced with special packing glands for operating on ammonia lines, but for such an enormous pressure extra care and attention has to be exercised in order to prevent the escape of any gas. The experience which the A. A. Griffing Iron Company has had in manufacturing separators for use under difficult and adverse conditions enables them to furnish just what is wanted.

Walker Apparatus.—Among the foreign orders recently received by the Walker Company, are twenty double No. 3-S street car equipments, three single No. 3-S equipments and eighteen double No. 3-N equipments, for Paris, besides four 150-k.w. belted generators with two generator panels. Messrs. Bagnall & Hilles, of Yokohama, have ordered two 25-k.w. direct-connected generators for Singapore. Recent domestic orders include two 150-k.w. 3-phase synchronous motors for the Lachine Rapids Power Company; a 700-k.w. alternator, single phase, for the Buffalo & Niagara Falls Electric Light & Power Company; two 400-k.w. belt driven generators for the Syracuse Construction Company, and one 120-k.w. belted generator for the Northern Electric Company,

The Belknap Motor Co.
OF PORTLAND, MAINE,

are very busy in the manufacture of Chapman Voltage Regulators; about ¼ of their entire force is devoted to this work alone. Orders have recently been received from Bath (N. Y.) Illuminating Co., New Haven Electric Light Co.; Potomac Electric Light Co.. (third one ordered within few months). Northern Electric Light Co., Philadelphia; Middletown (Conn.) Electric Light Co., three regulators. Pawtucket R. I. Electric Co.; Mutual Electric Light Co., St. Antonio, Tex.; Mt. Morris Electric Co., New York City, (two) recent shipments of Chapman Regulators have been made, (2) Johnstown, Pa.; Electric Co., Stockton, Cal., Gas & Electric Co., B. C.; Smelting & Refining Co., Trail, B. C.; People's Electric Co., Orange, N. J.; Thomas Oakes & Co., Bloomfield, N. J.; Clute Bros., Cohoes, N. Y.; H. T. Cushman Mfg. Co., North Bennington, Vt., Lebanon (N. H.) Electric Co.; Haverhill (Mass.) Electric Co., &c., &c. The sale of Motors and Dynamos manufactured by this company is lively at the present time; their New York and Boston representatives, Brewster Eng. Co, 27, Thames Bldg., and the L. I. Fletcher Co., Boston, are hustlers and no mistake. About 200 H. P. in motors having been received from Brewster Eng. Co. since Jan. 1st, and a similar amount from L. I. Fletcher Co., more than 40 machines being sold since Sept. 25th by the latter company.

Modern Switchboards.
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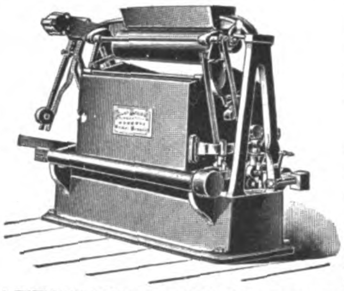
of Baltimore. The Norton & Attleboro Railway, of Attleboro, Mass., has purchased four double No. 4-A-S and two double No. 5-S equipments, besides a 250-k.w. direct-connected railway generator. Besides the generator above referred to, the Northern Electric Company, of Baltimore, has ordered 100 Walker arc lamps, making in all 300 in three months. The company has also recently taken a contract from the Government to build three disappearing gun carriages for 8-in. rifles of the Crozier type, '96 model.

CORRESPONDENCE INSTRUCTION. — Our esteemed contemporary, the *Electrical Engineer*, has established the "*Electrical Engineer* Institute of Correspondence Instruction," the methods of which are based upon a new system of instruction similar to that employed in the Toussaint Langenscheidt system of language teaching, now in extensive vogue abroad. The requirements for admission to the course is nothing more than ability to read and write. The elementary courses begin with simple arithmetic, and an unlimited time is granted the student to complete his course of instruction, teaching being continued without extra charge until the student has acquired a diploma or a certificate of efficiency or until he voluntarily resigns. Text books are to be furnished without extra charge. The course may be sold or transferred at any time, and extensions of time in case of shortness of funds will be granted. In short, the aims of the institute are to enable anyone desirous of obtaining a thorough knowledge of the electrical and allied arts to acquire it through the instrumentality of carefully prepared printed lessons supplemented by a system of confidential correspondence carried on between the student and the institute, in which the student is at liberty to ask as many questions as he likes, until he is satisfied that he thoroughly grasps every point in the lesson he is studying. The direction of the institute instruction has been placed with Mr. Herman A. Strauss, E. E., an engineer with thorough electric and mechanical training, acquired in this country and abroad, and who also brings to his work a practical experience in teaching.



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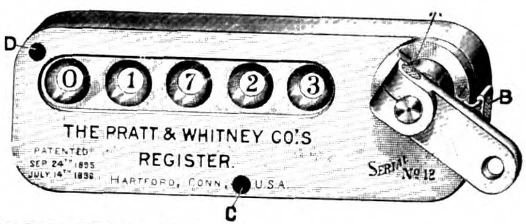
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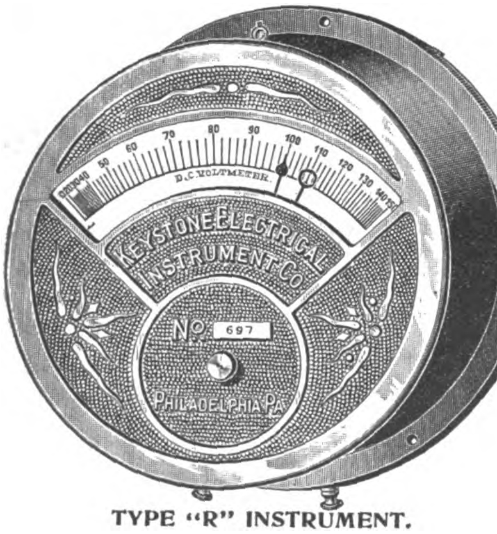
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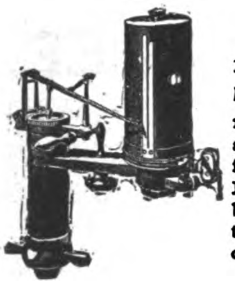

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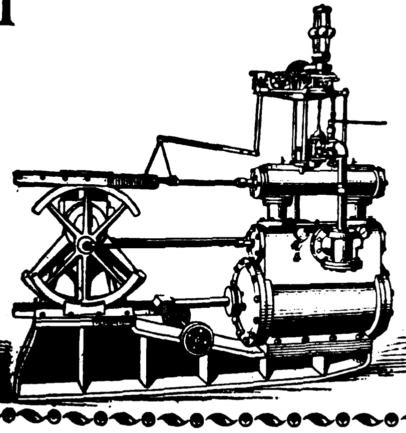

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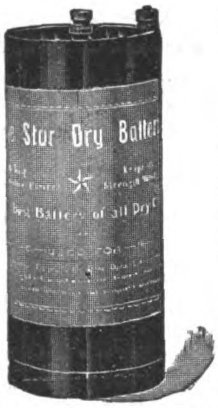

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Four 45-light 1,200 Cp. No. 7 Brush Arc Dynamos, oil cup bearings, dials, sliding base, pulley, etc.

One 1,000-light National alternator, 1,000 volts, 16,000 alternations, complete with switch board instruments and exciter, and an extra armature for Alternator.

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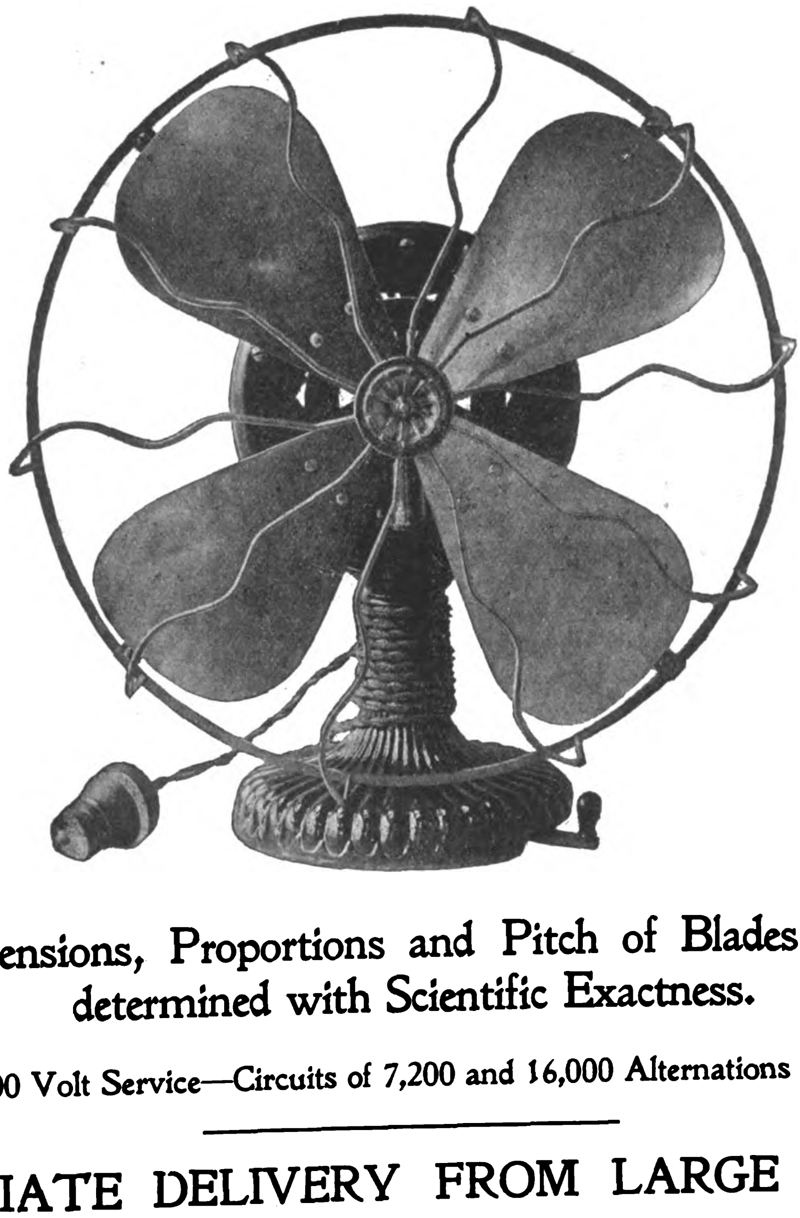

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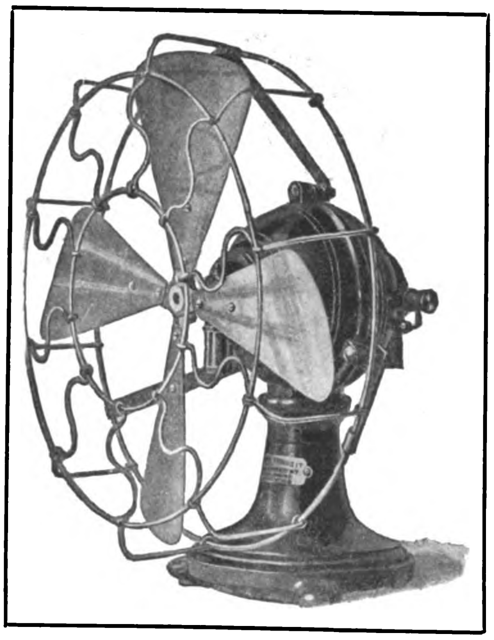

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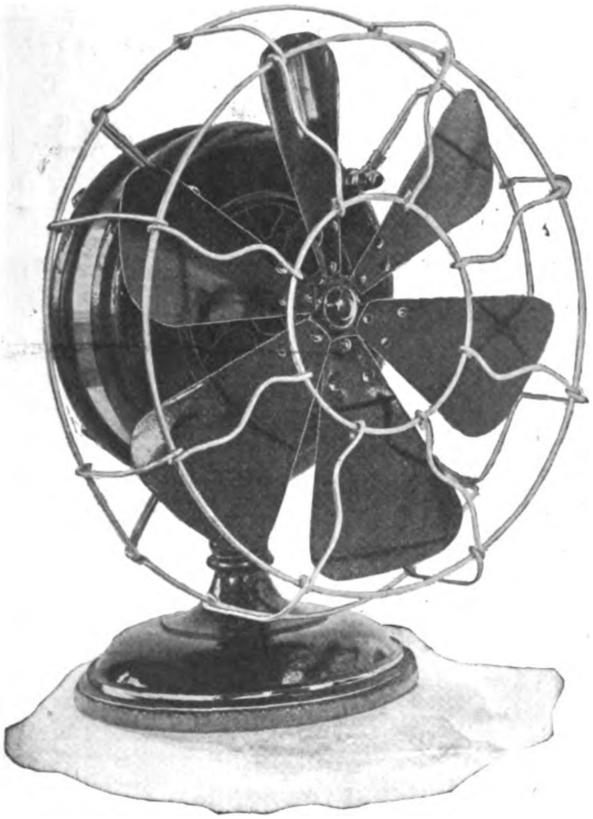

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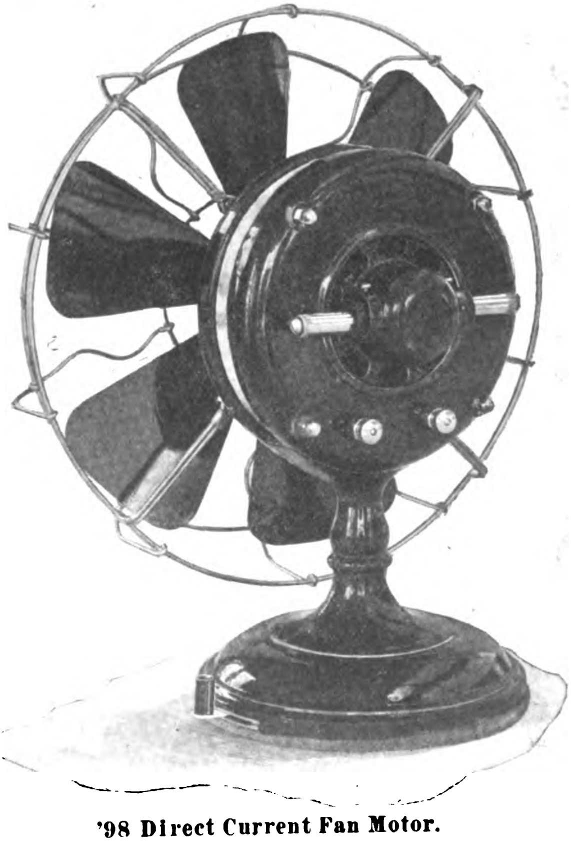

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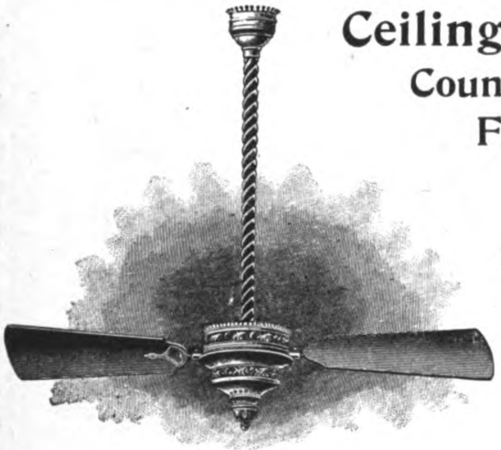

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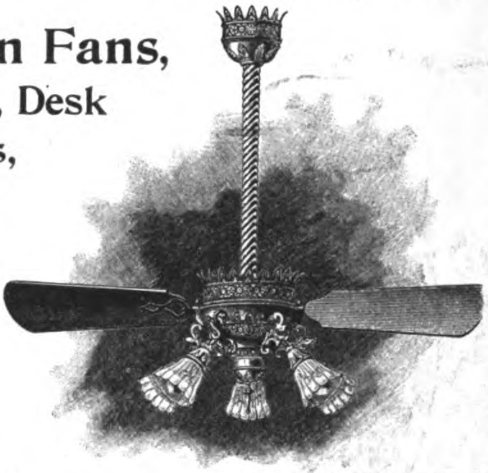

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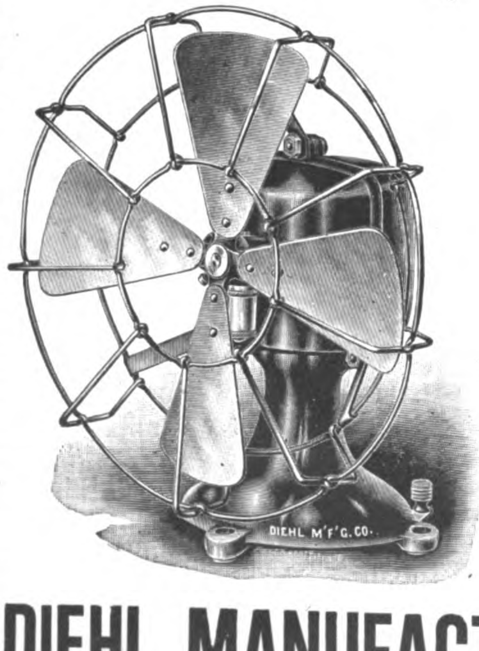
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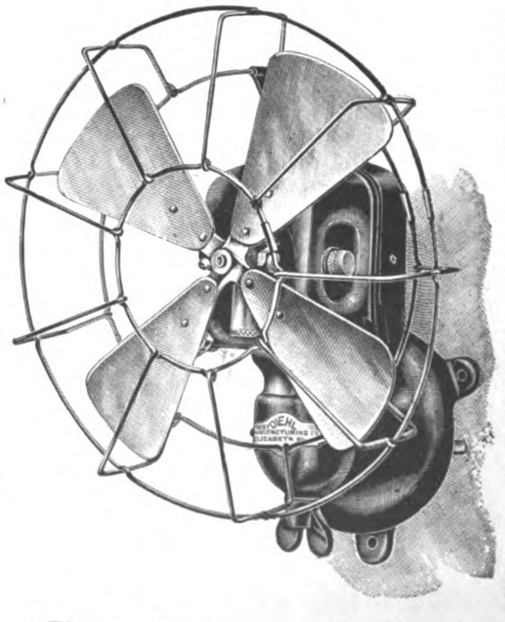

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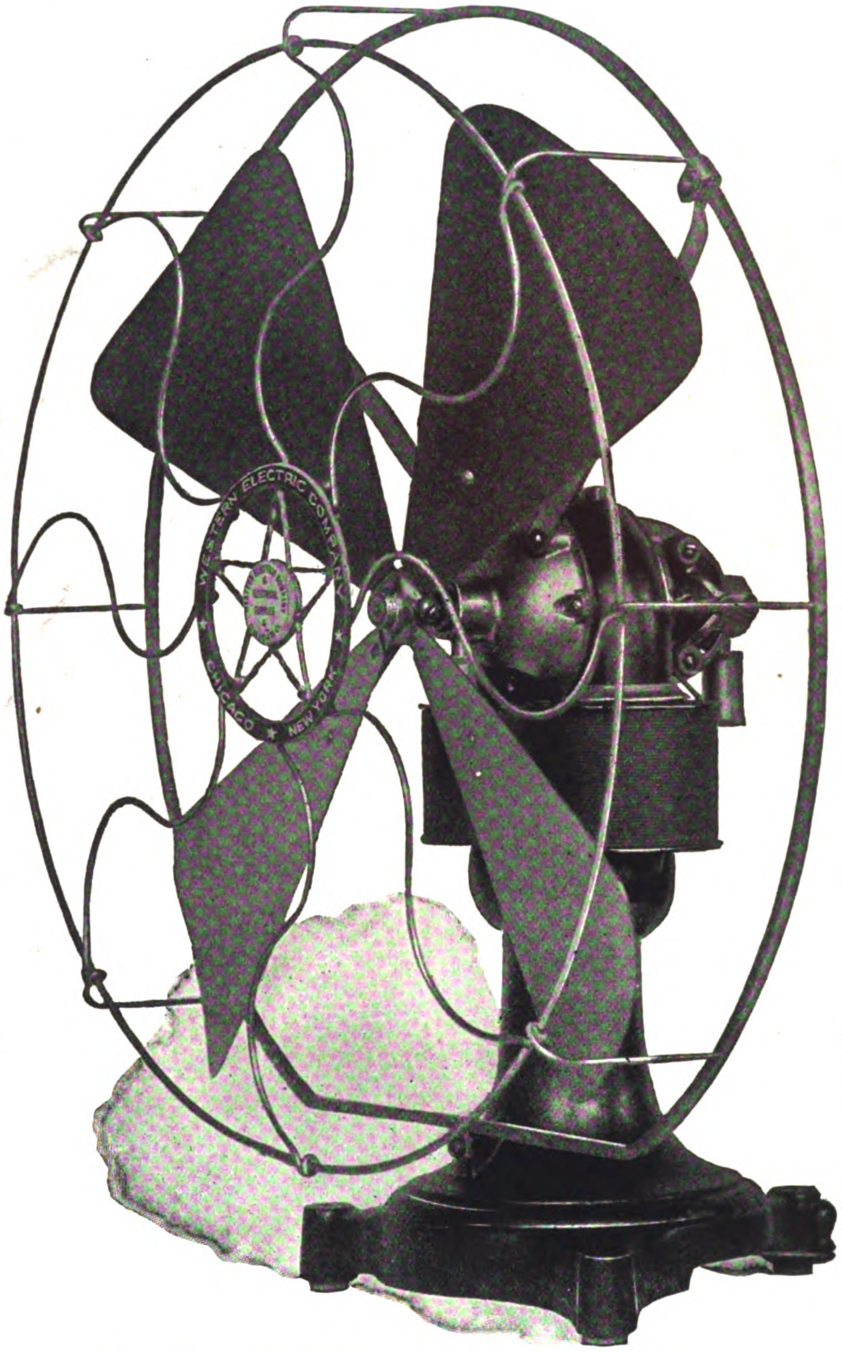

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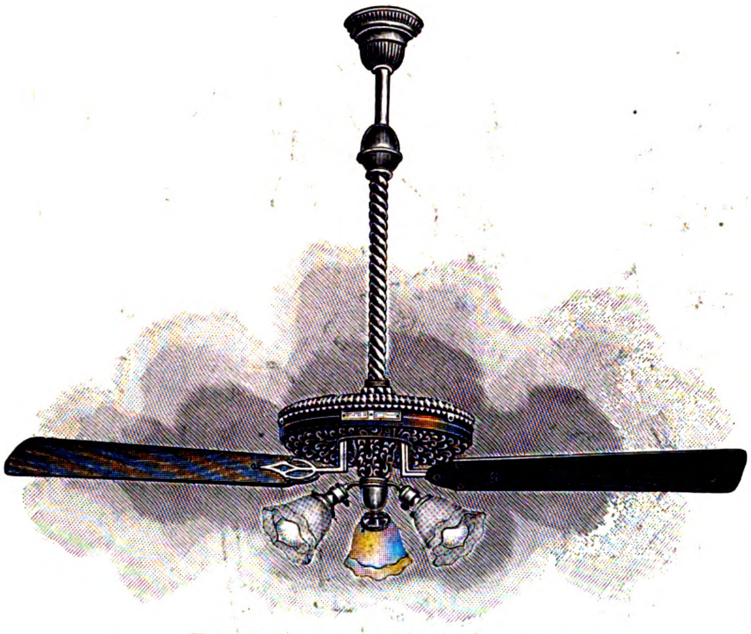

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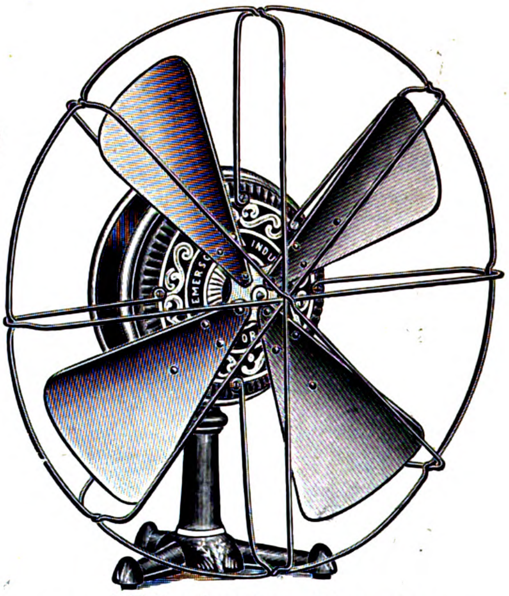

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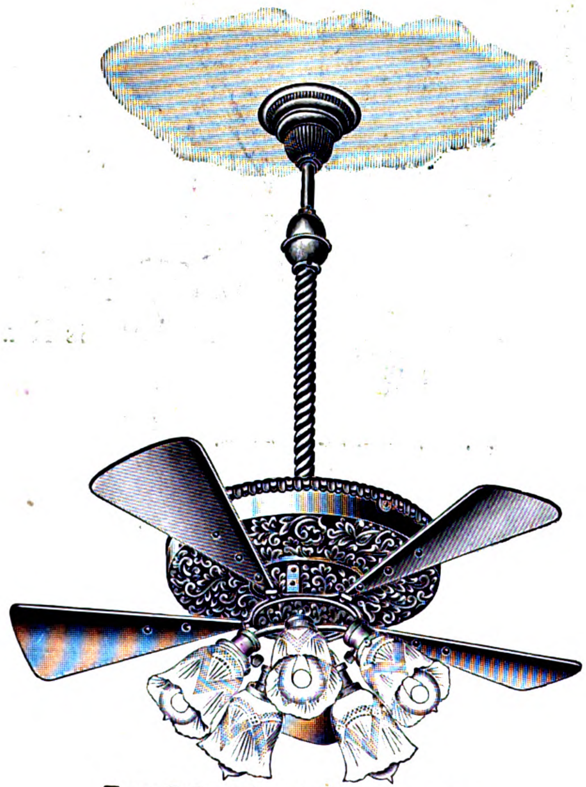

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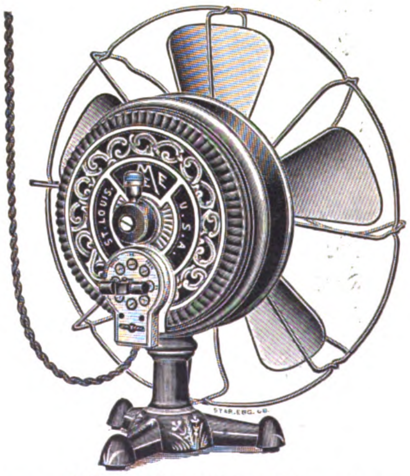

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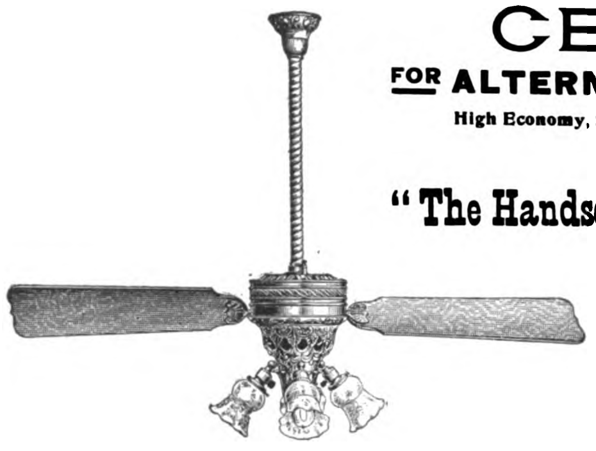

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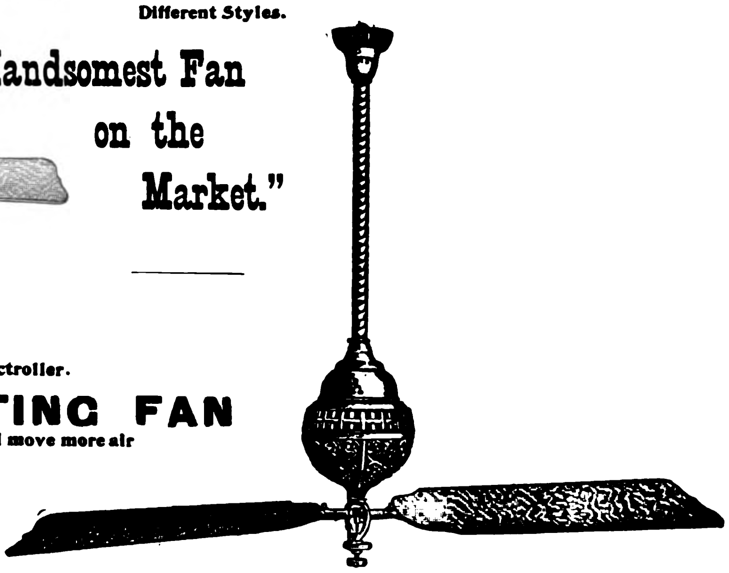

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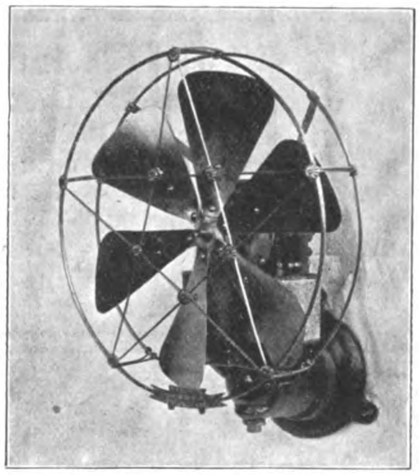

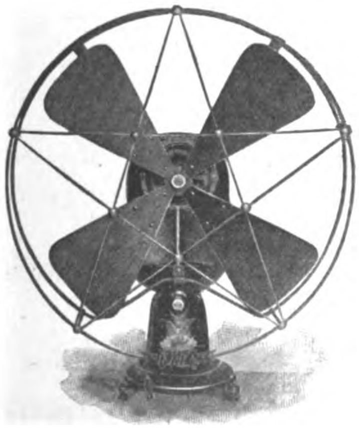

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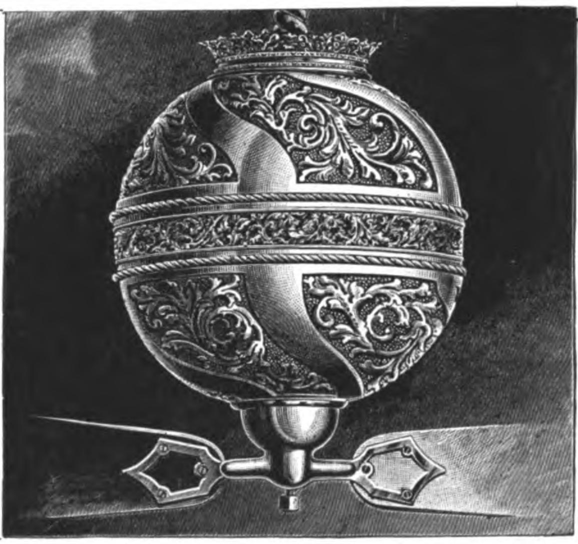

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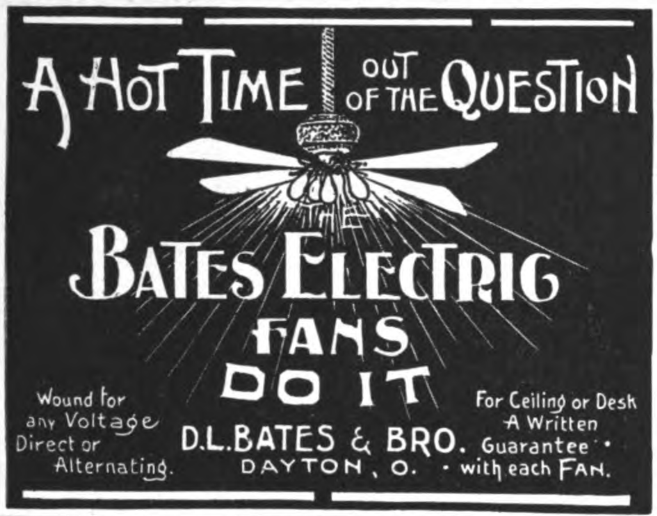
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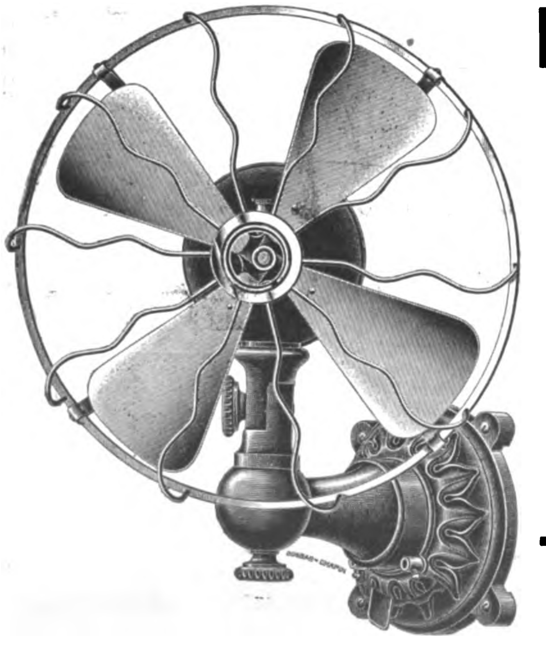

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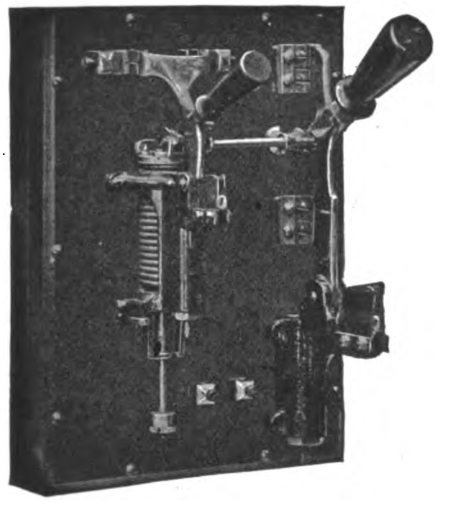

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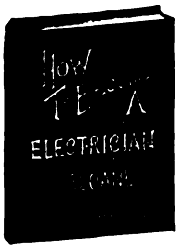

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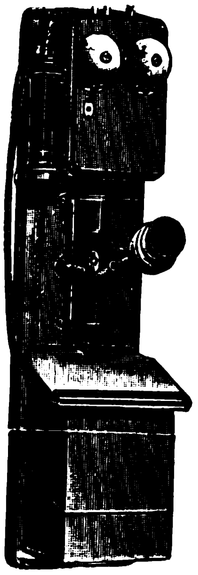

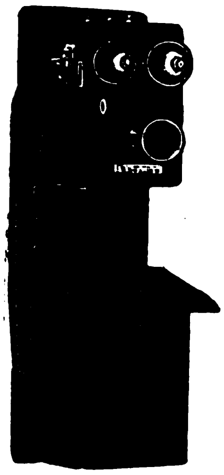

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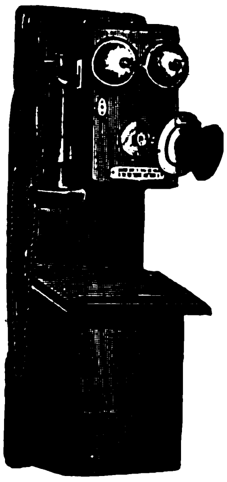

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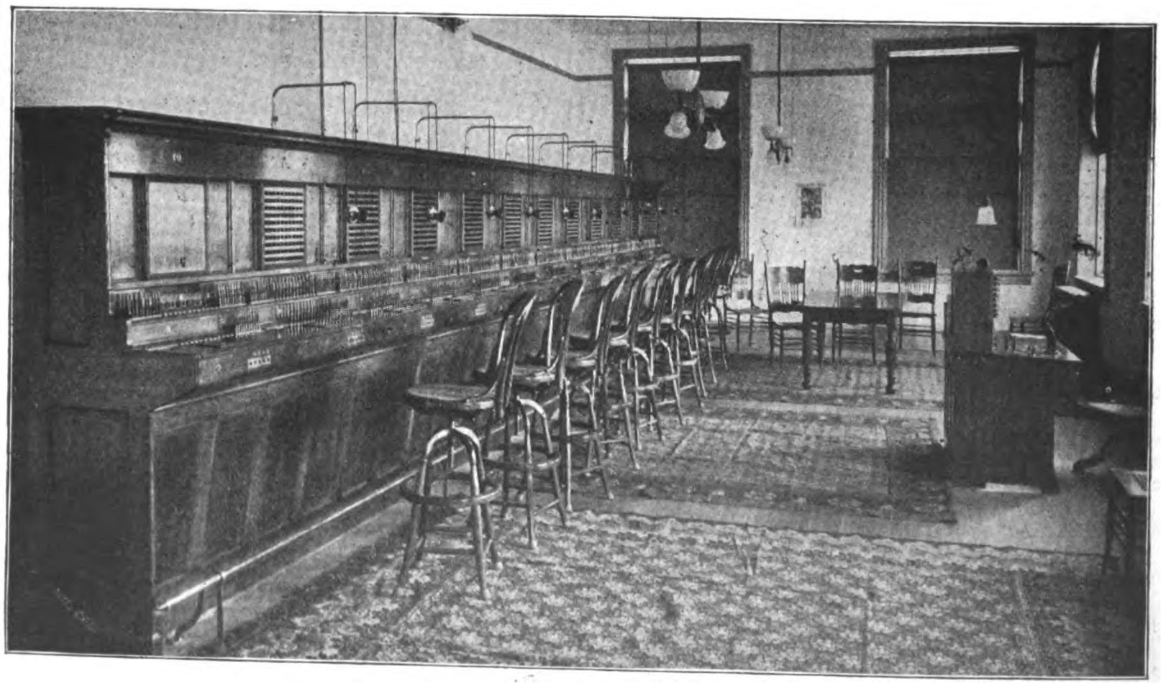

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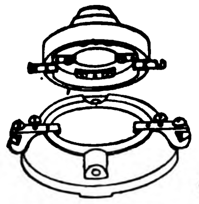

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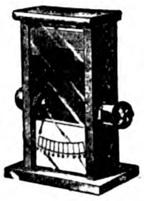

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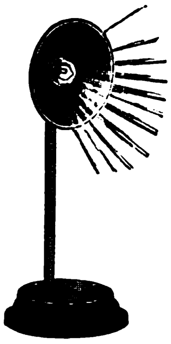

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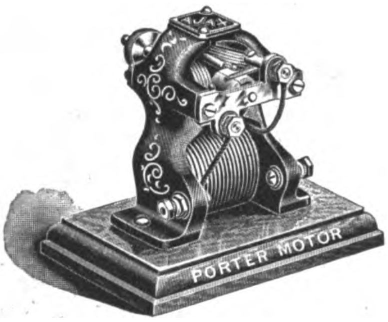

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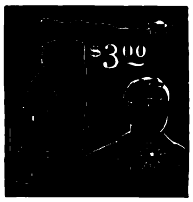

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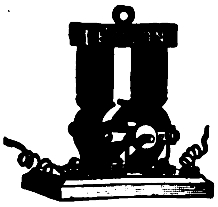
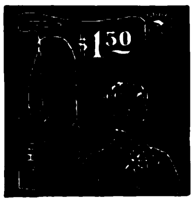


Dollar Motor.



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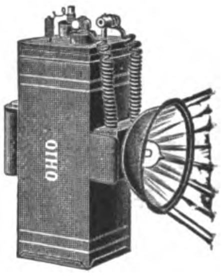

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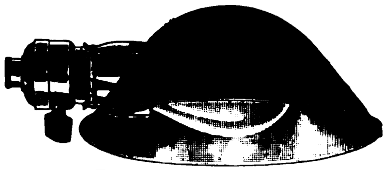

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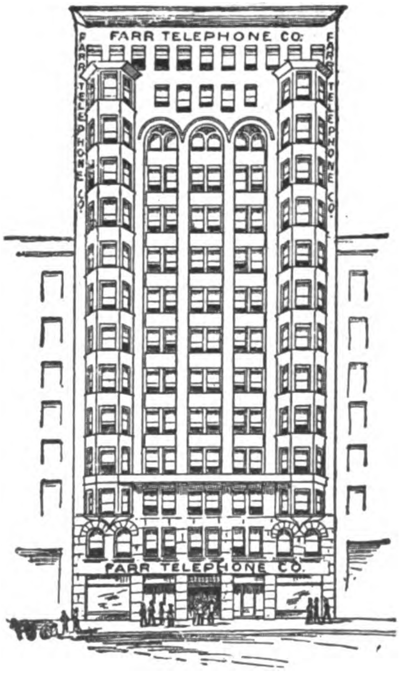
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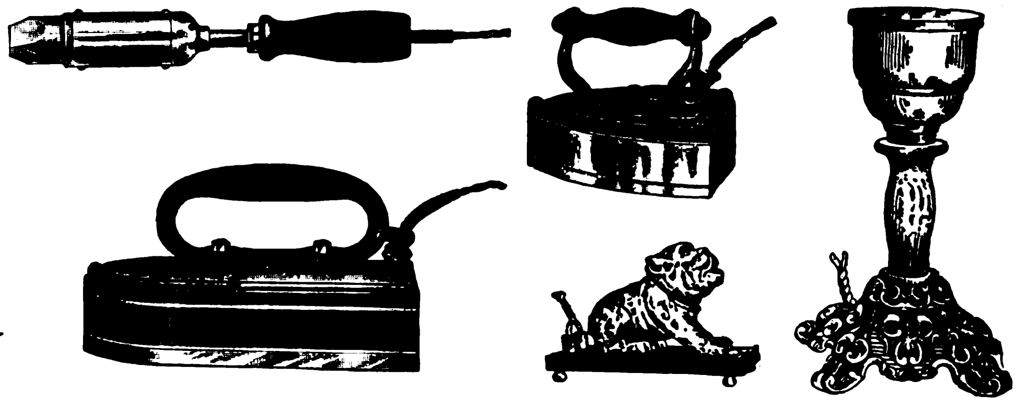

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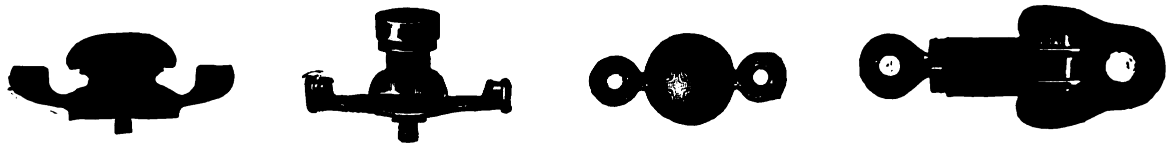

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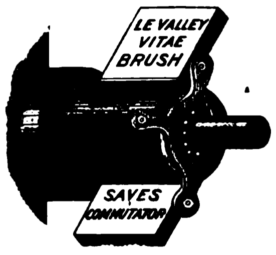

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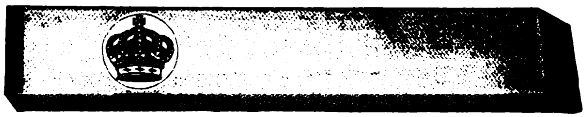

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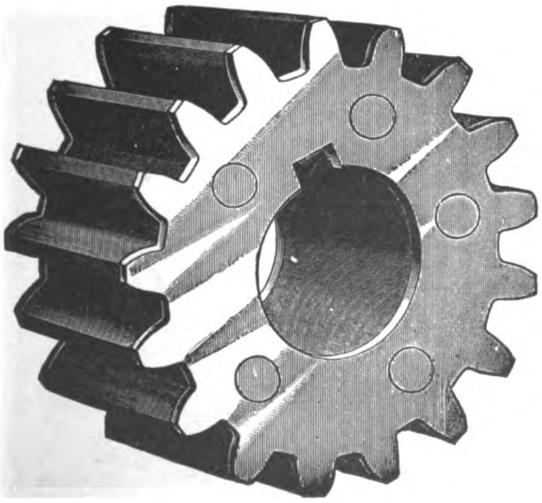

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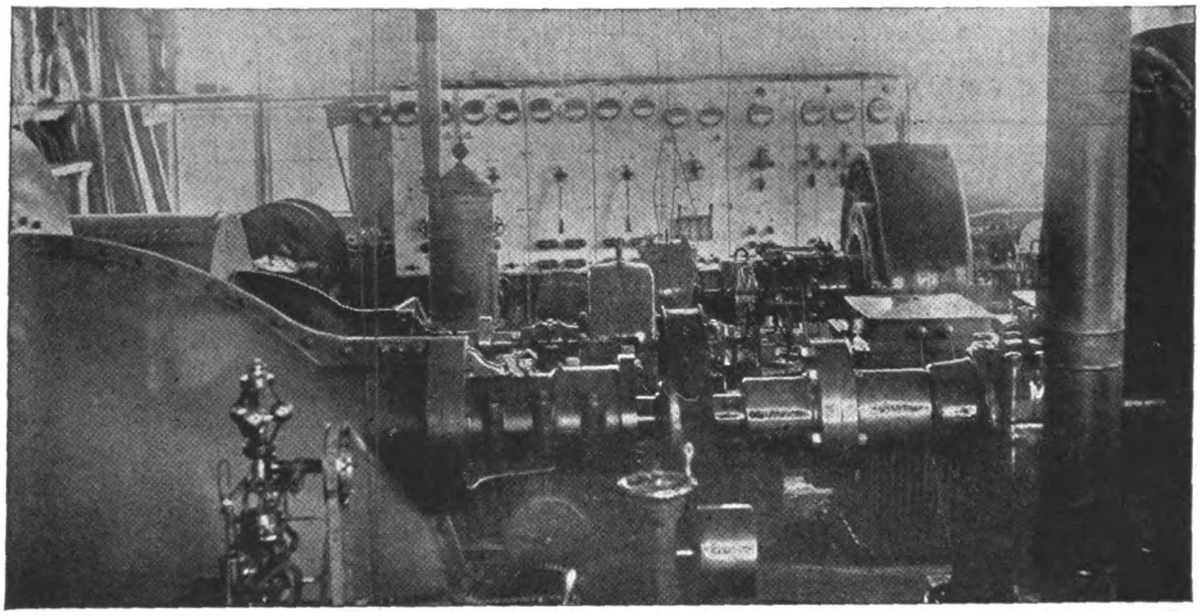

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Vol. X. New York, May, 1898. No. 5.

ST. ANTHONY FALLS WATER POWER PLANT.

The construction of the recently inaugurated water power electrical generating plant at St. Anthony's Falls was undertaken by the St. Anthony Falls Water Power Company, the plant when completed being leased to the Twin City Rapid Transit Company for the purpose of furnishing power to all the street railway systems of both Minneapolis and St. Paul, which are operated by the Twin City Company. The engineers of both the above named companies worked in unison and the result is most creditable, whether viewed from the standpoint of hydraulic, mechanical or electrical engineering. It is interesting to note that the plant has supplanted more steam driven belted electric machinery with its direct connected generators and rotary converters, than any plant in the world.

A visit to one of these railway substations is most instructive as it will show the great advance made in the last few years in electrical apparatus. It seems almost impossible at the first glance to realize that the neat and compactly built rotary converters with their respective banks of transformers, could replace the ponderous triple-expansion engines, counter-shafting and endless amount of belting, and battery upon battery of boilers, economizing besides the space before used for the storage of coal.

Three of the old power stations have practically been closed, and are now used as substations for the accommodation of the rotary converters. These, of course, take up much less floor space compared with the former plant; in fact, room enough was obtained to install the converters without removing any of the old plant.

Water Rights.—The site of the present plant is located in Minneapolis just below the great St. Anthony Falls of the Mississippi, where there is a long stretch of rapids. The power company has the water right for the entire width of the river at this place, but great care has to be taken not to interfere with the water rights of companies located above the plant, for if too much water were held back by the dams of the St. Anthony Company, the head above would be considerably diminished. This is amply taken care of in a manner which will be explained later. Fig. 10 is a map of the site of the plant.

Main Power Station.— The power house is located at the end of the main dam on the north side of the river, as shown in Figs. 7 and 10, and in reality forms a portion of the dam. The foundations are built of cut

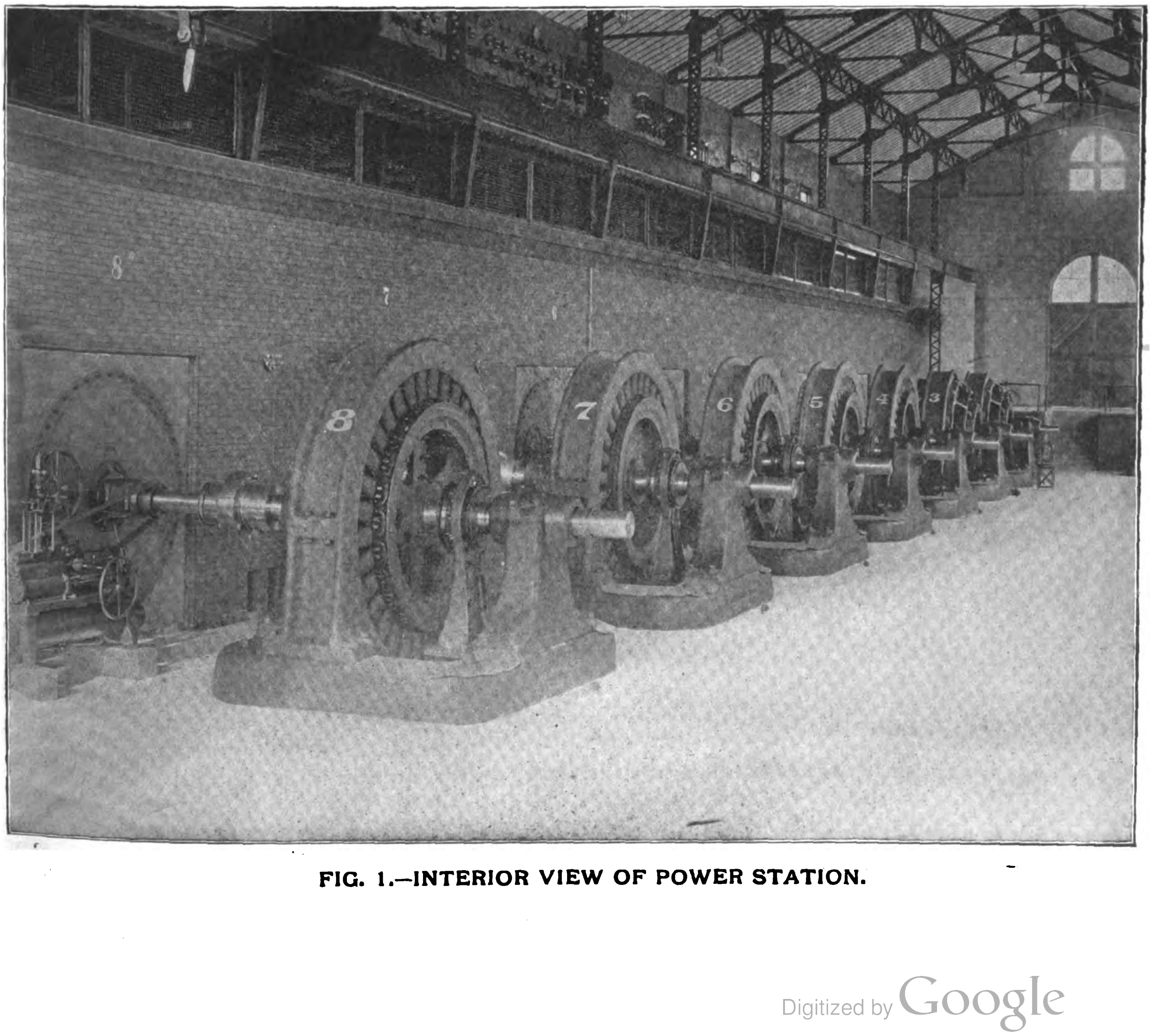

FIG. 1.—INTERIOR VIEW OF POWER STATION.

granite and the walls are of hollow tiling with sandstone trimmings. A steel frame, as shown in the interior view of the power house (Fig. 1), supplements the wall and supports the roof, which is covered with slate. This cut gives a general interior view of the station, showing the generators which are already installed. The station is 250 ft. long and 80 ft. wide, outside measurement, and there is accommodation for ten 700 k.w. units directly coupled to horizontal water wheels. The height of the building from floor to ridge of roof is 45 ft. Ample room is provided, as will be seen in the illustrations, for the installation of engines if it is found necessary to use them at times of low water or when the plant is increased. The station is also provided with an electric crane capable of handling any of the machinery in the station. The cross sectional view, Fig. 3, represents the station as originally designed; as built the roof structure is different, and the switchboard gallery is in a recess in the side wall of the electrical generator room, as shown in Fig. 1. The arrangement of machinery in Figs. 2 and 3 is, however, properly shown. Fig. 2 is a plan view of the station showing the arrangement of the turbines and generators, as actually installed, except that each unit is not provided with an exciter, there being two separately driven exciters, as elsewhere described.

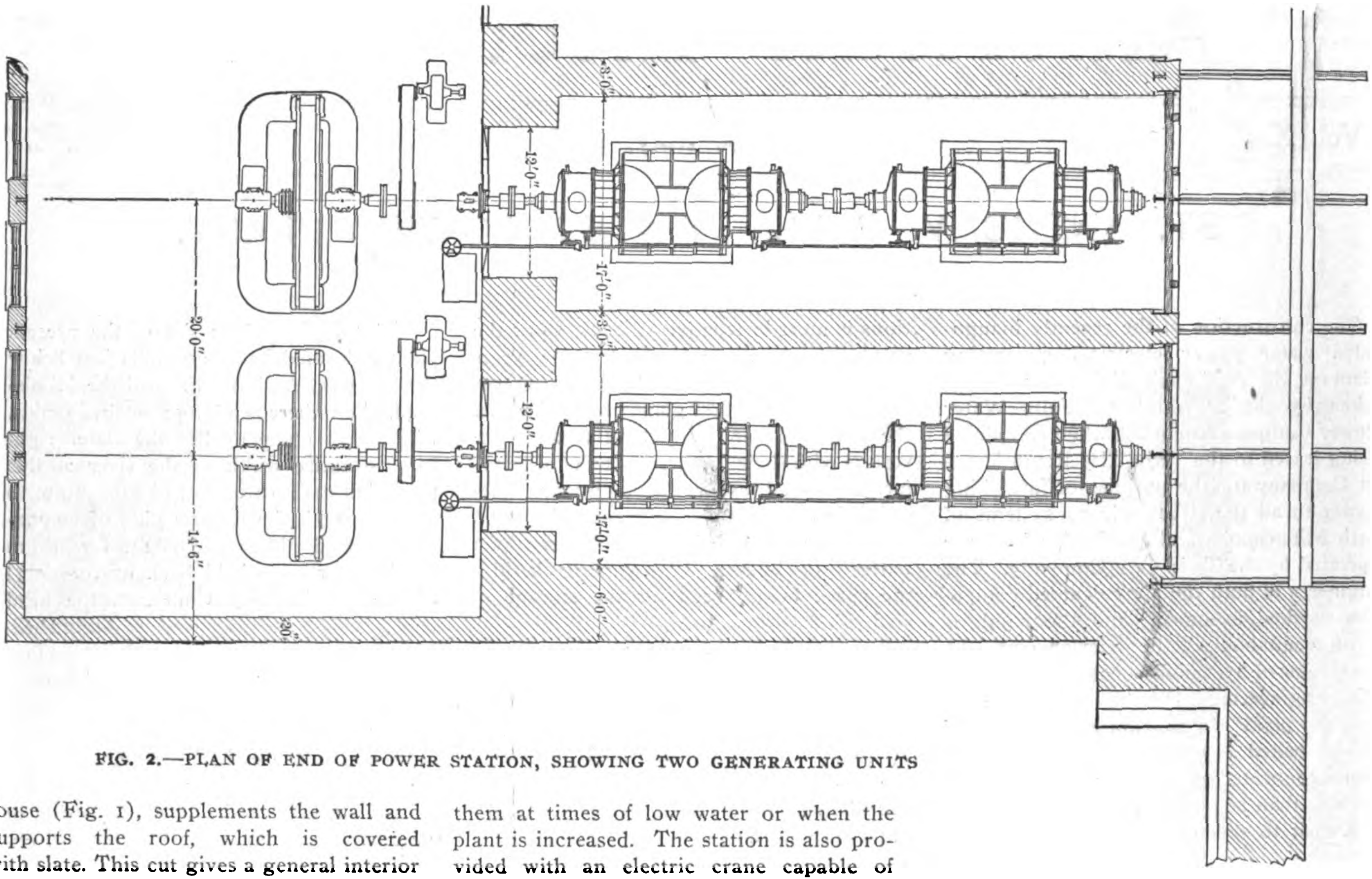
8'0"
12'0"
17'0"
8'0"
12'0"
12'0"
6'0"
20'0"
14'6"
20'

FIG. 2.—PLAN OF END OF POWER STATION, SHOWING TWO GENERATING UNITS

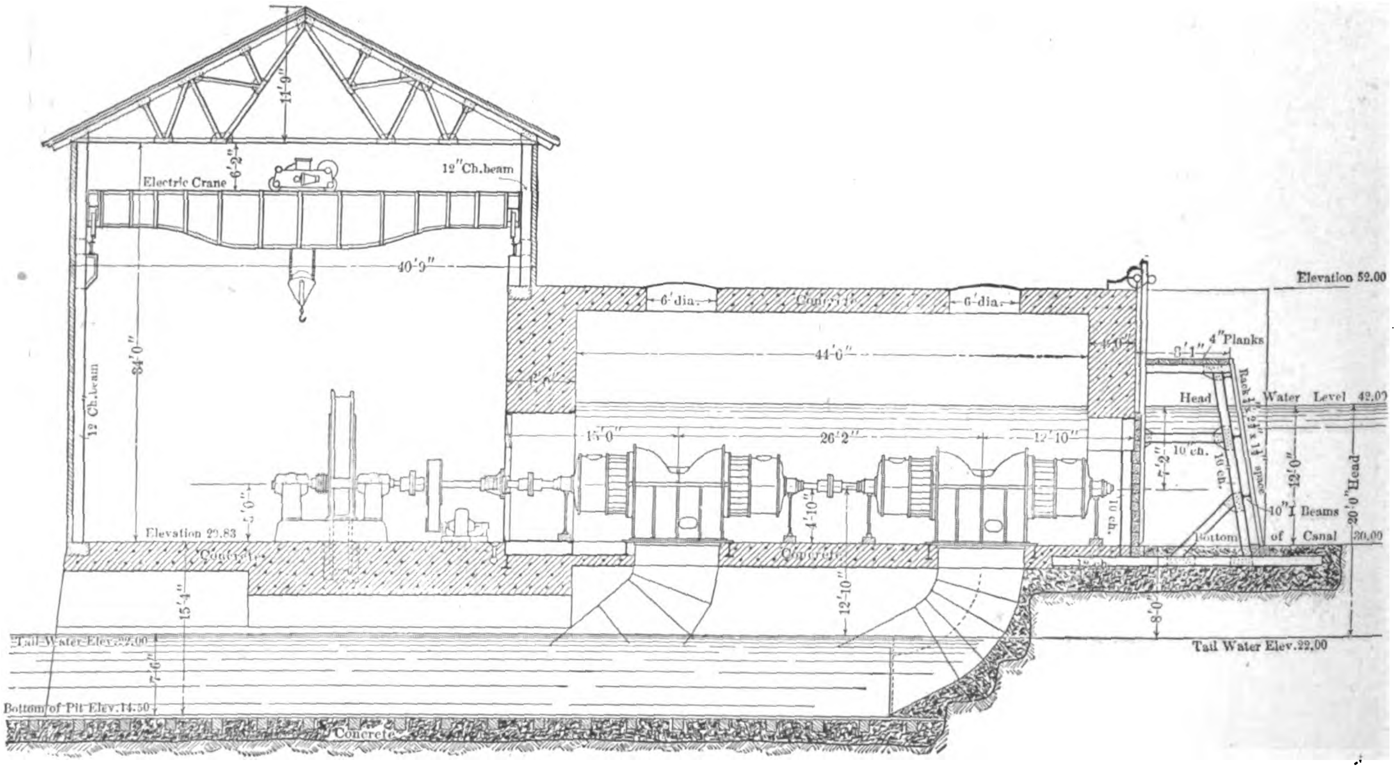
11'9"
6'2"
Electric Crane
12"Ch.beam
40'9"
84'0"
12 Ch.beam
Elevation 29.83
Concrete
15'4"
7'6"
Tail Water Elev. 22.00
Bottom of Pit Elev. 14.50
Concrete
6' dia.
Concrete
6' dia.
44'0"
15'0"
26'2"
12'10"
4'10"
12'10"
5'0"
10' ch.
Elevation 52.00
4"Planks
6'1"
Head
Rack
Water Level 42.00
10' ch.
7'2"
12'0"
10" I Beams
Bottom of Canal 30.00
20'0" Head
8'0"
Tail Water Elev. 22.00

FIG. 3.—CROSS-SECTIONAL VIEW OF POWER STATION AND WHEEL HOUSE

Hydraulic Work.—The dam is shown in

LIB ARY

Figs. 7 and 10. The retaining wall can be seen in Fig. 7, and extends along the north shore 740 ft. from the power station to a point a short distance beyond, where the wing and head dam form an angle. This wall had to be built for the protection of the bank, and is constructed entirely of cut granite. It forms one side of the fore bay, which is also well shown in Fig. 6.

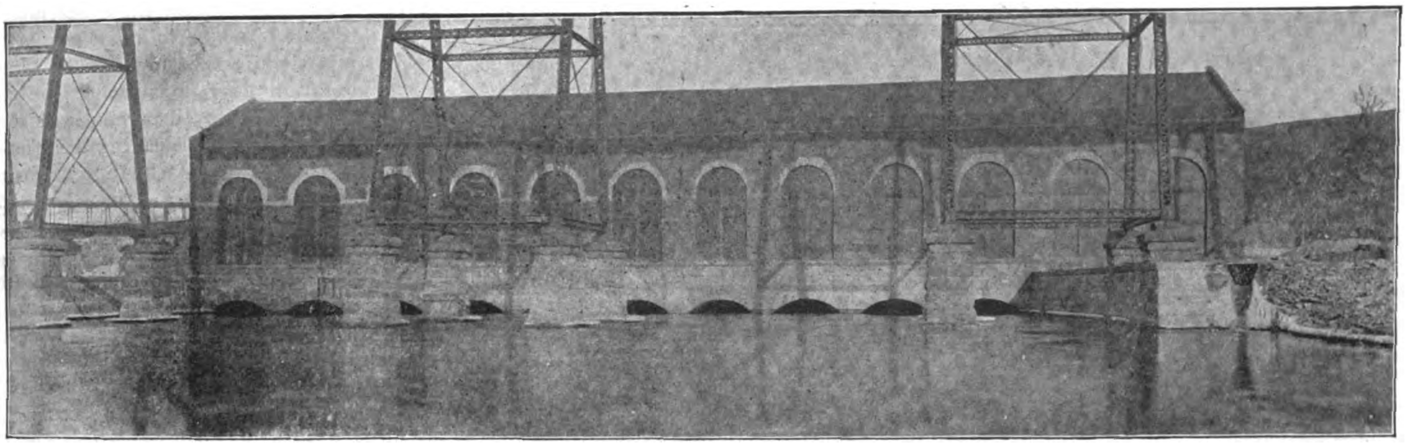

FIG. 4.—POWER STATION AND TAIL RACE

As may be seen from Fig. 10, the main cross-wall starts from the west bank of the river and runs directly across for a distance of 500 ft. This is the length of the wall proper, and does not include gates or waste ways. It then branches off at an angle and runs down stream nearly parallel to the east bank for 370 ft., to the upper end of the large waste way, shown in Fig. 4, close to the power station. Between the waste way and the power house the wall is continued, but at an increased height. All of the construction is of the best cut granite laid in cement.

As before stated, the power house forms a portion of the dam. There is a rack at the fore bay side of the power house extending its full length, and the water, after passing through this, enters the wheel chamber and flows from the draft tubes into an arched tail race underneath the power house.

In addition to the main wheel chamber there is another small chamber at the north end of the building, used for the purpose of driving two exciters.

The head has a maximum of 22 ft. and a minimum of 16 ft., with an average of 20 ft. The wheel chamber wall can be seen from an inspection of Fig. 1, which also shows the switchboard, placed on top of it; it is faced for its entire length with glazed brick. Fig. 8 also shows a portion of the wall and one of the direct-current generators.

The set of waste gates near the power station, shown in Fig. 6, are known as "bear traps." They are made in two sections. The apron, M (Fig. 9), forming the gate proper, is hinged at its lowest point, and the support against which it rests, or, more properly speaking, which supports it, is another apron, N, somewhat smaller in size, placed some distance in front of it, and having rollers, R, along the entire top edge. These rollers rest against the outer surface of the main apron.

When the gate is fully open, the supporting apron closes down with the main apron on top of it. The gates are raised by simply opening a valve in a large pipe, A, B, under the apron, which allows the water to pass from the fore bay, underneath the gate and underneath the front of the apron having the rollers along the edge. The pressure of the water is sufficient to raise this gate and maintain it at any desired height. By means of an outlet, C, D, from the chamber between the gates, they can be instantly closed by shutting off the water at the intake and opening the valve, which allows the water below the gates to escape, when they will collapse upon themselves.

One of the strongest advantages of this gate is that the water in flowing over carries off all debris which comes into the forebay, and which would otherwise catch in the racks.

The gates in the south side of the river, indicated in Fig. 10, are of the ordinary

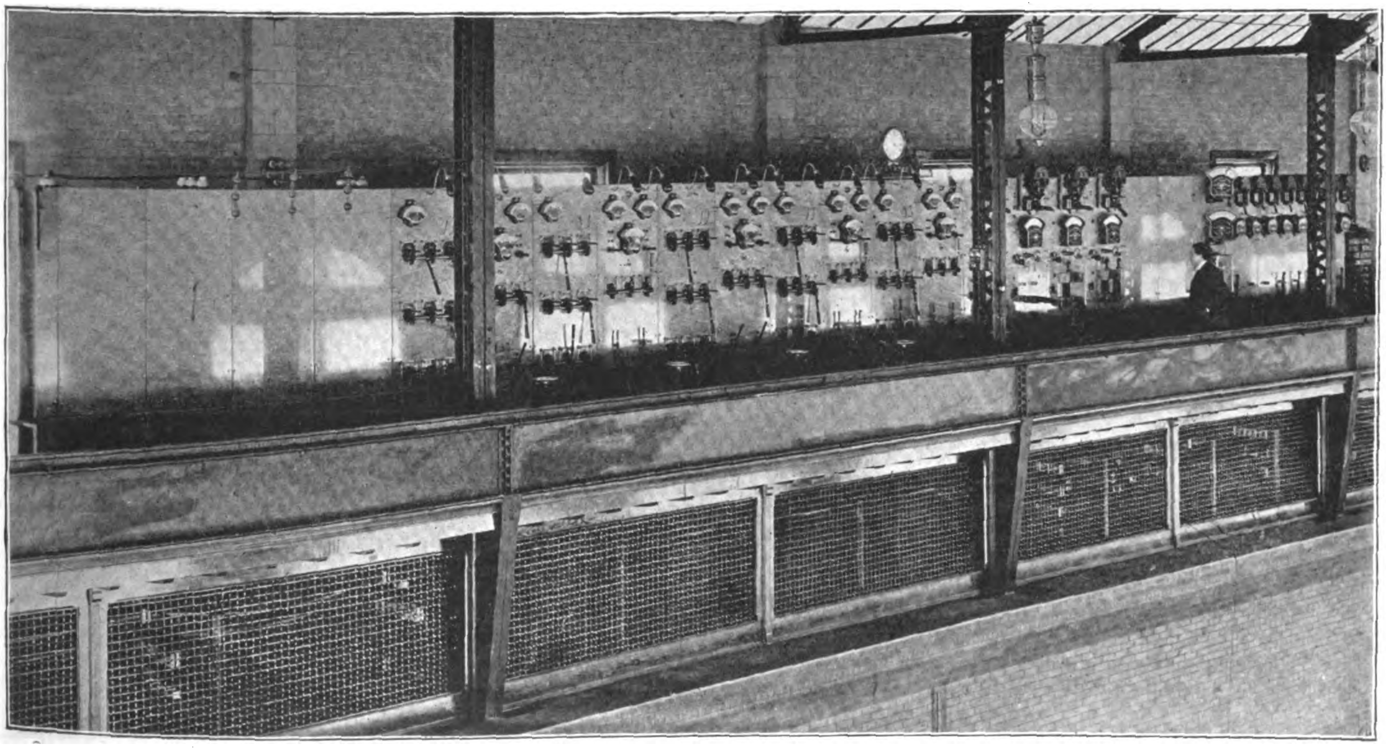

FIG. 5.—SWITCHBOARD AND CABLE RECESS

slide type and three in number. They are operated by large screws furnished with ball bearing nuts and operated by a small water wheel placed in one of the piers.

In addition to the granite walls forming the dam, there is a wing wall running from the power house side of the bear trap gates to a position below the abutment of the railway bridge, shown in Fig. 7. The top of the wall is shown to the extreme left of Fig. 4. This wall is to protect the power house and keep the tail race clear.

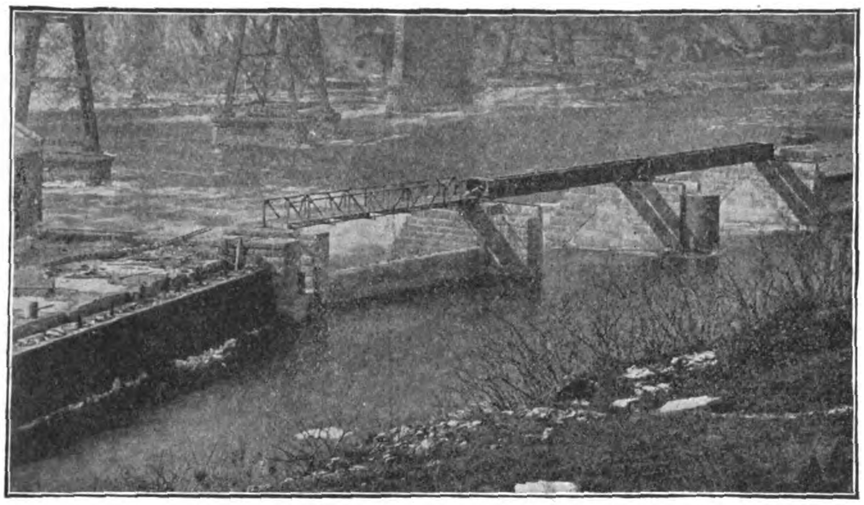

FIG. 6.—BEAR TRAPS

Water Wheels.—The main water wheels for this plant were furnished by the Stilwell-Bierce & Smith-Vaile Company, and are of their well known Victor type. As shown in Fig. 2, to each 700-k.w. unit there are two pairs of 42-in. horizontal wheels, giving a total of four 42-in. wheels directly connected to each generator shaft. These wheels are designed and guaranteed to develop 1000 h.p. per set, or 250 h.p. each.

This method of installing wheels is an innovation in low head work and forms an exceedingly compact and efficient unit.

In addition to the wheels just described there are two sets in the wheel chamber at the east end of the house, which were manufactured and installed by the D. S. Morgan Water Wheel Company. These wheels are for the purpose of operating generators for furnishing exciting current to all the three-phase machines in the station.

Governors.—The governors were furnished by the Lombard Water Wheel Governor Company, one of which is shown in Fig. 8, driven by a belt connected to a small pulley on the generator shaft. The excellent results given by these governors in other installations leaves no question as to their satisfactory operation in this plant. Each governor operates the gates for each full set of four wheels.

Electrical Apparatus.—All of the electrical apparatus installed in this plant was manufactured by the General Electric Company. In the main station there are at present installed five 700-k.w. three-phase generators having 32 poles and operating at a speed of 130 revolutions, giving frequency about 35. One of these is shown in Fig. 13.

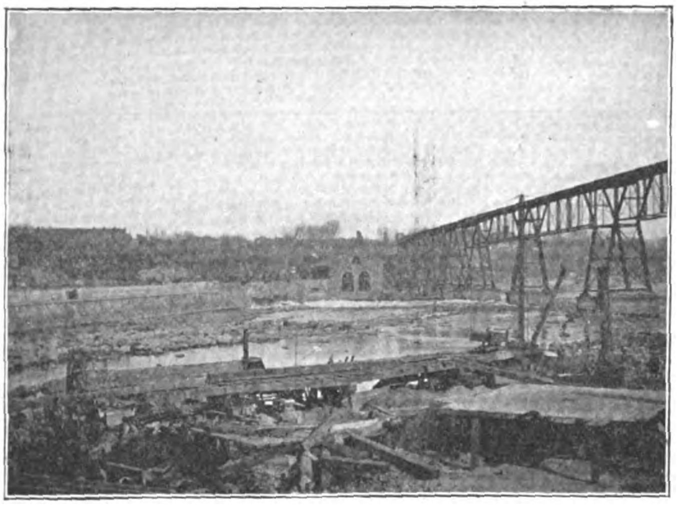

FIG. 7.—POWER HOUSE FROM SOUTH SIDE OF RIVER

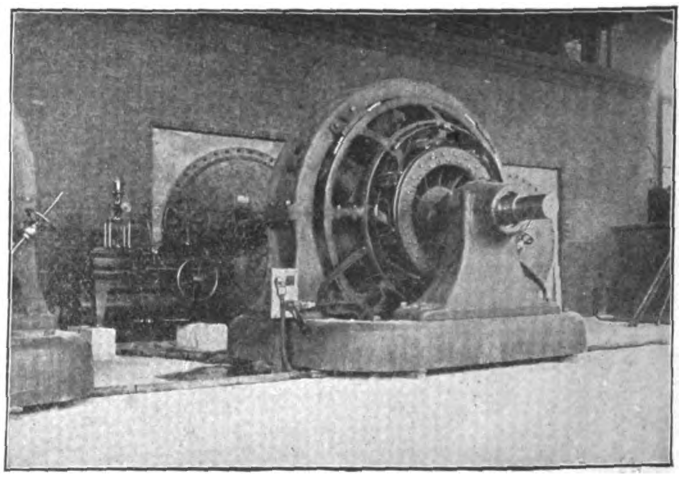

FIG. 8.—700 K. W. DIRECT CURRENT GENERATOR

These machines are of the well known General Electric type, with the field poles built up of laminae thoroughly insulated from each other by a coating of japan. The poles and windings are arranged in such a way that the windings can be easily removed from the magnet yoke without disturbing either the armature or the field frame.

The field winding is wound on shells and insulated therefrom by oiled cotton tape and veneer. The armature is of the iron-clad type, ventilated by means of ⅜-in. air ducts; the armature laminae are dovetailed into the armature spider, thereby dispensing with the use of bolts through the core. The bearings on these machines are self-aligning and self-oiling, "genuine" babbitt metal being used for lining.

The base frame is so constructed that the field frame can be moved parallel with the shaft for the purpose of cleaning the armature or for repairs. The approximate weight of the armature is 25,000 lbs., and the complete weight of each machine about 84,000 lbs.

In addition to these machines, there are two direct-current 700-k.w. generators, having eight poles and running at a speed of 130 r.p.m. These machines are wound for a pressure of 575 volts at no load, and over-compounded to a voltage of 600 volts at full load. They feed the 500-volt railway circuit direct through cables of 500,000 c.m. cross section.

The armature is of the well known iron-clad type and is ventilated by means of ducts in the core .4 in. in width. The armature winding on these machines consists of copper bars laid in the slots, the winding being of the type known as the "barrel."

The commutator is designed so that the current density at the point of contact with the brushes does not exceed 35 amp. per sq. in. at the full rating of the machine, and the difference of potential between commutator bars is very low.

There are two 100-k.w. six-pole exciters, running at a speed of 280 r.p.m., and wound for a voltage of 575 volts at no load, and over-compounded to 600 volts at full load. These machines have armatures of the iron clad type, ventilated in practically the same manner as the machines previously described.

Main Station Switchboard.—The station switchboard was designed with a view to having two separate sets of busbars, so

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that the attendant in charge may run any particular machine on either of the two busbars. A view of all connections of the main station and switchboard is shown in Fig. 12. This sketch shows the connections of the main station to all generators and also to the three rotary converter substations. There have been some minor modifications made in the wiring since this diagram was made, but none that are worthy of note, with the exception of the line to the St. Paul sub-station, which has but one circuit from the power station. A general view of the board is given in Fig. 5, which also shows the screens covering the cable recess. The switchboard consists of 23 panels, as follows:

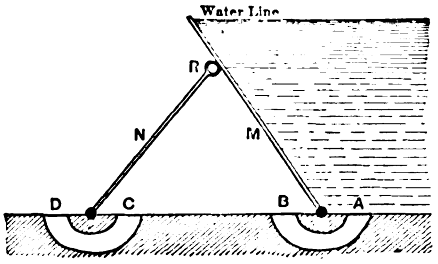

FIG. 9.—DETAILS OF BEAR TRAP

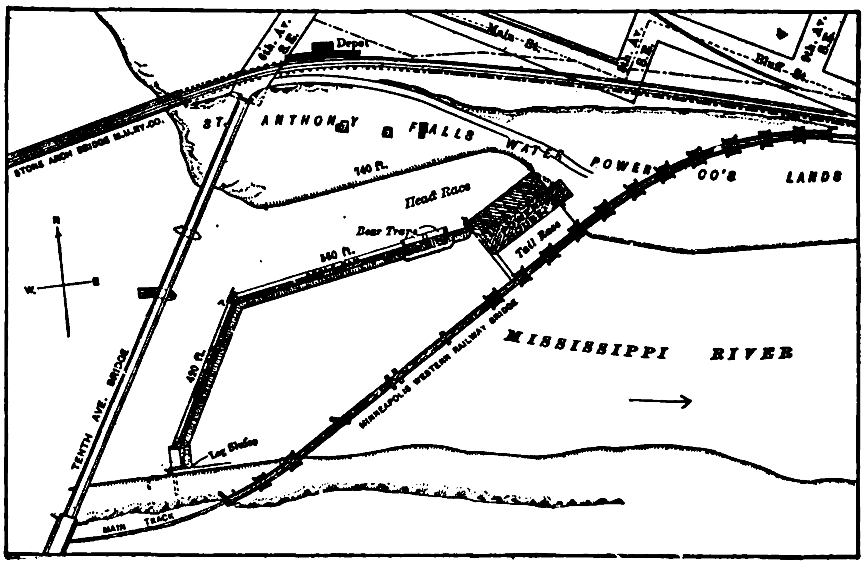

FIG. 10.—MAP SHOWING LOCATION OF PLANT

One station panel, equipped with one 700-volt, illuminated dial Weston voltmeter; one 2500-amp., 600-volt Thomson recording wattmeter, the panel being surmounted with a 12-in. dial 8-day clock and head-piece.

Five alternating current generator panels, each equipped with one 200-amp., deadbeat, inclined coil ammeter; one 5250-volt inclined coil voltmeter and station transformer; one generator rheostat; one high-voltage main switch (porcelain chamber): two single-pole field switches; one 2-point phase lamp switch; two pilot lamps; one phase lamp and one potential plug; one 700-k.w. single-phase indicating wattmeter, and three fuse blocks.

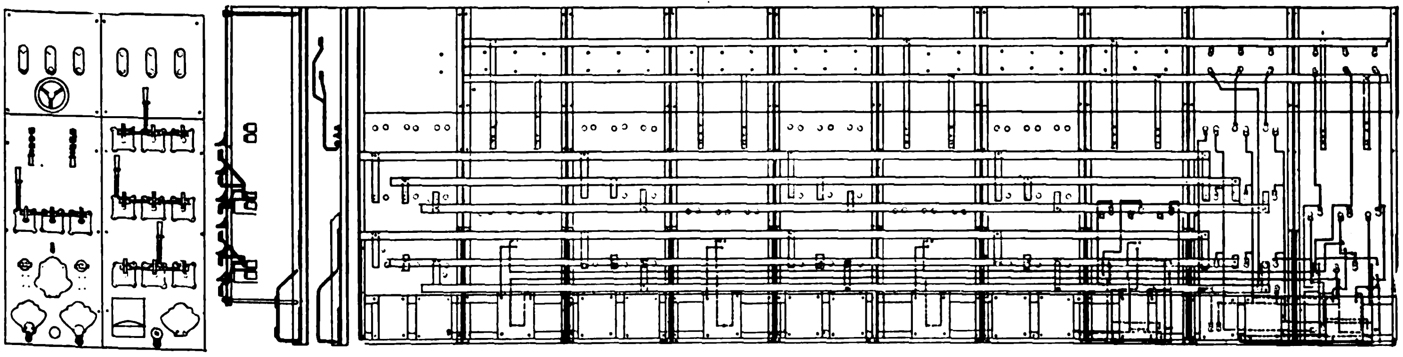

FIG. 11.—A. C. GENERATOR AND FEEDER PANELS AND REAR VIEW OF CONNECTIONS

Two continuous-current railway generator panels, each equipped with one 1200-2000-amp. circuit breaker; one 2500-amp. illuminated dial Weston ammeter; one generator rheostat; one lightning arrester; two single-pole, double-throw main switches; one lightning switch; one 2-way field switch; one potential plug; one pilot lamp; one resistance lamp, and two bus wires on the back. (Equalizer switches are furnished, but are located at the generator.)

Five alternating-current feeder panels, each equipped with one 200-amp., 3500-volt, alternating, three-phase Thomson recording wattmeter and two station transformers; three porcelain chamber, high-voltage coupling switches; one pilot lamp; six busbars at the back; one indicating wattmeter, 700-k.w. capacity (single-phase type); three fuse blocks.

Eight special railway feeder panels, each equipped with two 300-500-amp. circuit breakers; two 200-amp., round-pattern, Weston ammeters; one pilot lamp; two single-pole main switches; two busbars at the back.

Two exciter panels, each equipped with one illuminated dial Weston voltmeter; one round-pattern Weston ammeter; one rheostat; two single-pole, double-throw main switches; two single-pole field switches; two busbars at the back; one automatic circuit breaker.

The static switchboard shown in Fig 16 is for the purpose of taking care of static discharges. There are three panels, two being designed for the two 3500-volt circuits, and one for the 12,000-volt circuit. The only difference between the 12,000-volt and the 3500-volt panels is that the former has a greater number of discharge gaps and more graphite resistance. The panels are connected to the line through switches; the circuit of the static panels can be opened at any time without disturbing the flow of current in the line. This is for the purpose of cleaning and adjusting the discharge gaps with safety.

The fuse blocks on the alternating current panels are of the expulsion type, and each block has two fuses in parallel.

In addition to the panels just described, there are six blank ones, to be used when the remaining generators are installed; these consist of two A.C. generator panels two A.C. feeder panels, one D.C. generator panel and one station panel.

Transformers.—The static transformers in this plant are of the standard air-blast type and are 21 in number, of 233-k.w. capacity each. Six of these are placed in the main station for the purpose of raising the generator voltage from 3450 to 6900 volts, and the remaining fifteen are placed in the three substations, two containing six, and the third three.

This type of transformer is too well known to need an extended description, although it might be interesting to refer to some of the most important features of its construction.

The first and greatest aim in the manufacture of any transformer is to thoroughly insulate the high potential from the low potential windings. This is accomplished in this transformer through the method of cooling, which admits of a heavy insulation being placed on the coils without unduly restricting the escape of heat. In addition to this, solid diaphragms of heavy insulation are placed between the high and low potential coils. Air ducts separate this diaphragm on either side from the adjacent coils.

How effectively this insulation fulfills its duty may be judged from the fact that the transformers for this plant were tested with a 20,000-volt potential between primary and secondary windings, and it could have safely been tested for considerably higher voltages. Transformers of this type have been built for higher voltages with similar insulation, and have successfully withstood a test of 80,000 volts.

Another one of the problems connected with the building of large electrical apparatus is to properly dispose of the heat generated within the windings. This problem has been very successfully met in electrical apparatus which has revolving parts, by so designing these parts that they act as blowers, thereby setting up currents of air in their interior. It is not surprising then that this method, which has proved so thoroughly satisfactory in revolving apparatus, should prove equally satisfactory in static transformers.

In order to present the proper amount of surface to the circulating air, the coils of the transformer are separated from each other by narrow air ducts, and the sheet iron of which the transformer core is composed is separated into small groups by similar ducts.

The air is forced through a main duct which runs underneath all of the transformers. This forced draft is obtained from an electrically driven blower set, and the air, after passing through the coils in the core, escapes into the surrounding atmosphere, having absorbed the heat in its passage through the transformers. So carefully and thoroughly has this system been carried out that each transformer has some 350 sq. ft. of cooling surface. As a result, no portion of the windings have a temperature rise of more than 35 deg. C. above the surrounding air after having carried their full rated load for an indefinite time.

It is a fact worthy of note that this very effective cooling is accomplished with an expenditure of power of but one-tenth of one per cent of the capacity of the transformer.

The efficiency of these transformers is a fraction under 98 per cent. While this is not as high an efficiency as can be obtained in the design of transformers, it represents practically the most economical design where power is as cheap to produce as it is in this plant. Good regulation rather than extremely high efficiency is, of course, to be desired in a water power plant, and consequently the transformers were designed for the very close regulation of 1 per cent from no load to full load.

As is seen from the cuts, the transformers are very compact and of neat appearance. They are thoroughly protected by an enclosing case, no portion of the windings being exposed. The high potential coils have their terminals brought out through the casing in porcelain bushings, and rubber-covered cables connect these terminals to the lines.

The transformers are connected as follows: To receive 3450 volts on the primary and step-up, the two primary coils are placed in parallel and the transformers connected in delta on their primary side. To obtain 6900 volts on the secondary, the two secondary coils are placed in series and the transformers connected in delta on their secondary side. To obtain 12,000 volts, the primary connection is not dis-

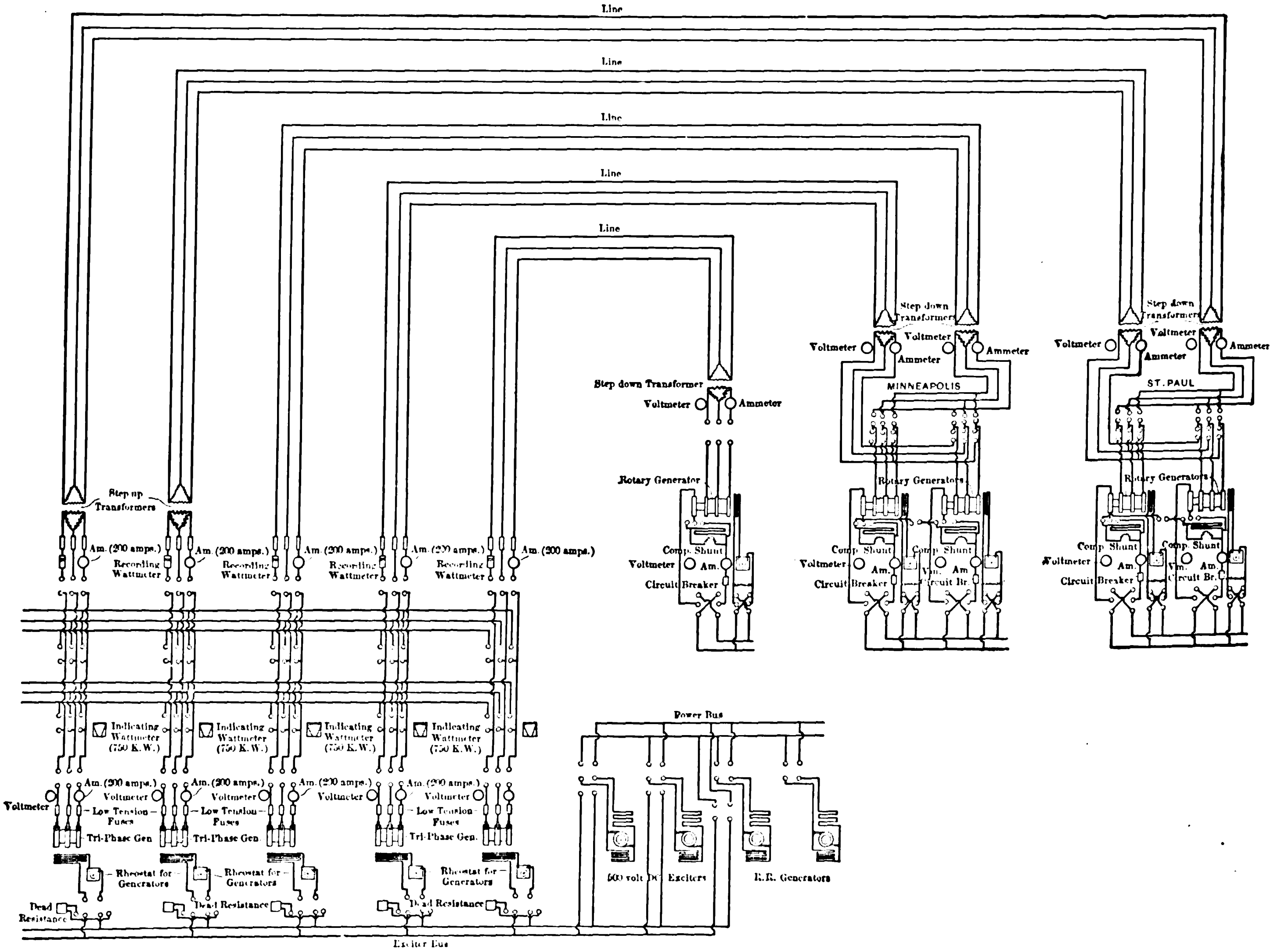
Line
Line
Line
Line
Line
Step up Transformers
Am. (200 amps.)
Recording Wattmeter
Indicating Wattmeter (750 K.W.)
Voltmeter
Low Tension Fuses
Tri-Phase Gen
Rheostat for Generators
Dead Resistance
Exciter Bus
Step down Transformer
Voltmeter
Ammeter
Rotary Generator
Comp. Shunt
Am.
Circuit Breaker
Step down Transformers
MINNEAPOLIS
ST. PAUL
Rotary Generators
Vm.
Circuit Br.
Power Bus
600 volt DC
Exciters
R.R. Generators

FIG. 12.—POWER STATION, TRANSMISSION AND SUB-STBTION CIRCUITS

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turbed, but the secondary is connected in Y with the two secondary coils in series. From this connection we obtain $6900 \sqrt{3}$, or 11,937 volts.

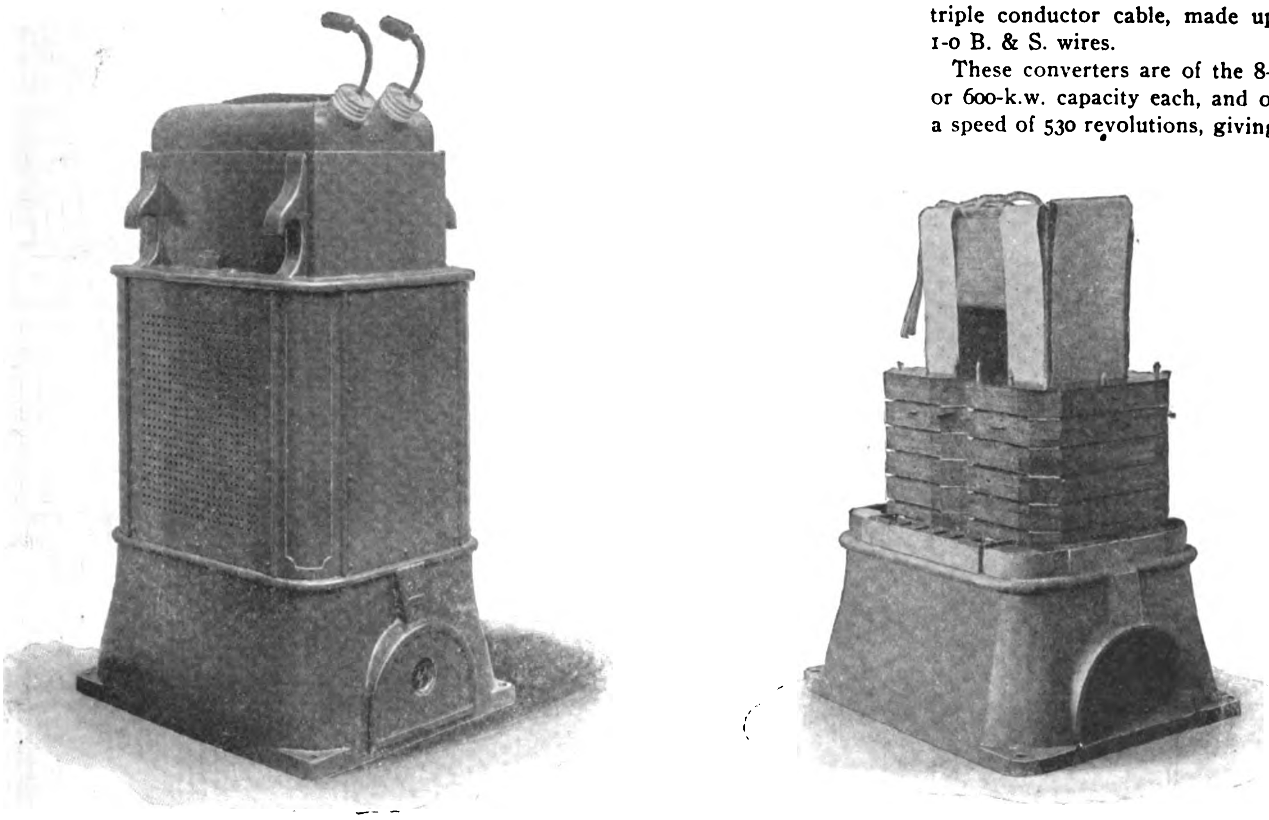
The dimensions of the transformer are, height, 58 ins.; floor space, 38 ins. x 32¾ ins.; weight, approximately, 4500 lbs.

Induction Coils.—A three-phase open magnetic circuit inductance coil is placed between the transformer and each rotary in order to give greater range of adjustment in the direct current voltage of the rotary.

On most power transmissions there is sufficient inductance in the system, due principally to the inductance of the line, to allow a considerable range of adjustment in the voltage of the rotary by changing the field excitation without any considerable idle current being produced.

In this transmission, due to the comparatively short distances between generator and rotary, and to the extensive use of cable rather than overhead line, the inductance of the system is so low that the introduction of this artificial inductance is necessary in order to get the desired flexibility in the voltage.

These coils also serve the purpose of preventing any idle current circulating between two rotaries operated from the same transformers when their field adjustment is not carefully made.



FIGS. 14 AND 15.—233 K. W. AIR BLAST TRANSFORMER

The coils themselves are so simple as to hardly need description, consisting simply of bundles of iron wire, with a finely stranded cable wound around them, the three being assembled in a protecting case, through which circulates a small current of air obtained from the same blower that cools the transformers.

Each of the three sub-stations is provided with three 50-inch Buffalo blowers, each directly connected to a 4-pole, 2½-h.p., 600-volt, motor, operating at a speed of 500 r.p.m.

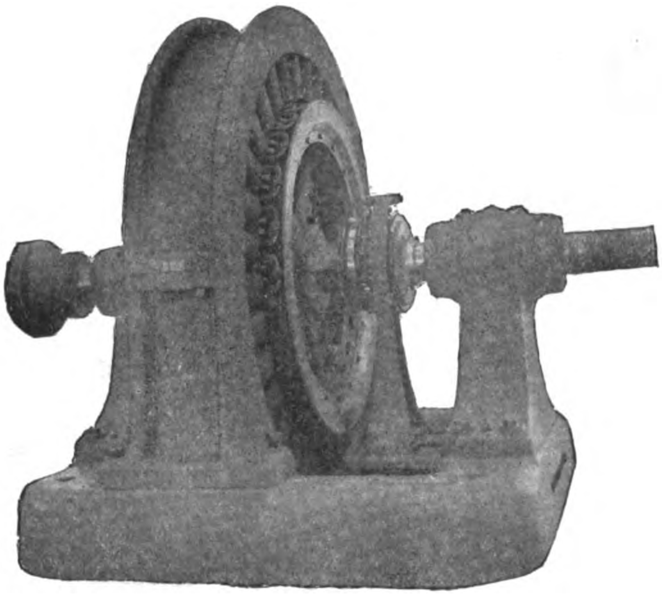


FIG. 13.—700 K. W. THREE-PHASE GENERATOR

Rotary Converters.—There are installed in the three sub-stations five rotary converters. Two of these are in what is known as Substation No. 1, located in the heart of the city of Minneapolis, and 9000 ft. from the power station, current being transmitted at a pressure of 3500 volts over two triple-conductor paper-insulated, lead-covered cables, each equivalent to No. 3-0, B. & S., and furnished by the National Underground Conduit & Cable Company. Another is in Substation No. 2, located in Minneapolis, and 23,700 feet distant from the power station, and operated at the same potential as No. 1 Station, through one triple conductor cable, each conductor being 4-0 gauge. Two are in Substation No. 3, located in St. Paul, distant about ten miles from the power station. The current is transmitted at a potential of 12,000 volts through one triple conductor cable, made up of three 1-0 B. & S. wires.

These converters are of the 8-pole type, or 600-k.w. capacity each, and operated at a speed of 530 revolutions, giving 580 volts on the direct current side at all loads up to normal.

The armature is of the iron-clad type, and is thoroughly ventilated by means of 5-16 in. ducts. The armature spider is calculated for a safety factor of 6, and so constructed that all shrinkage strains are obviated; the laminae are dovetailed into the armature spider, dispensing with the use of bolts in the core.

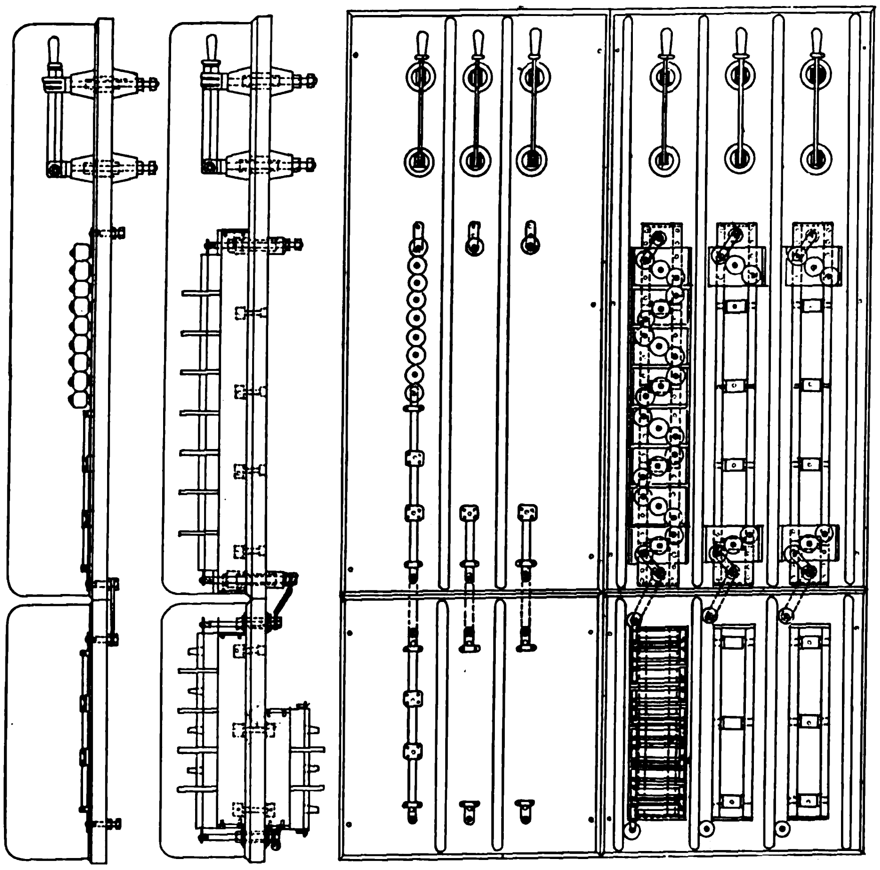


FIG. 16—STATIC DISCHARGE PANEL.

The commutator is assembled on a separate spider, mounted upon the armature spider. The voltage delivered to the A. C. side of the rotaries is approximately 350 volts.

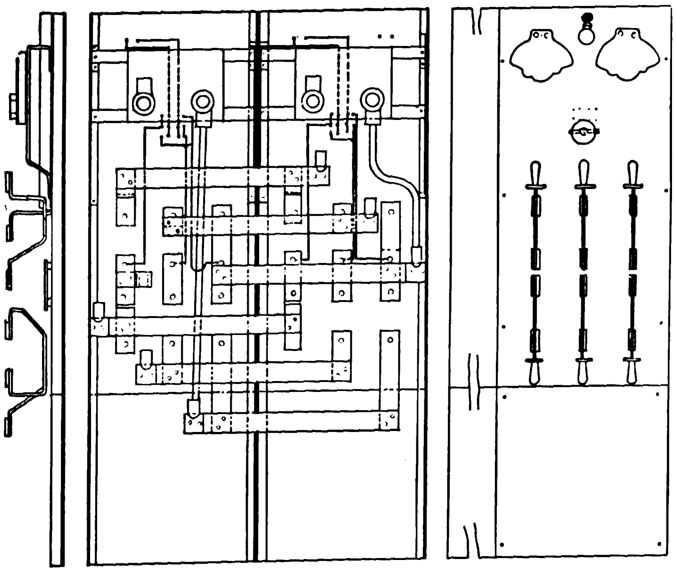


FIG. 17—ROTARY CONVERTER PANEL, A. C. SIDE.

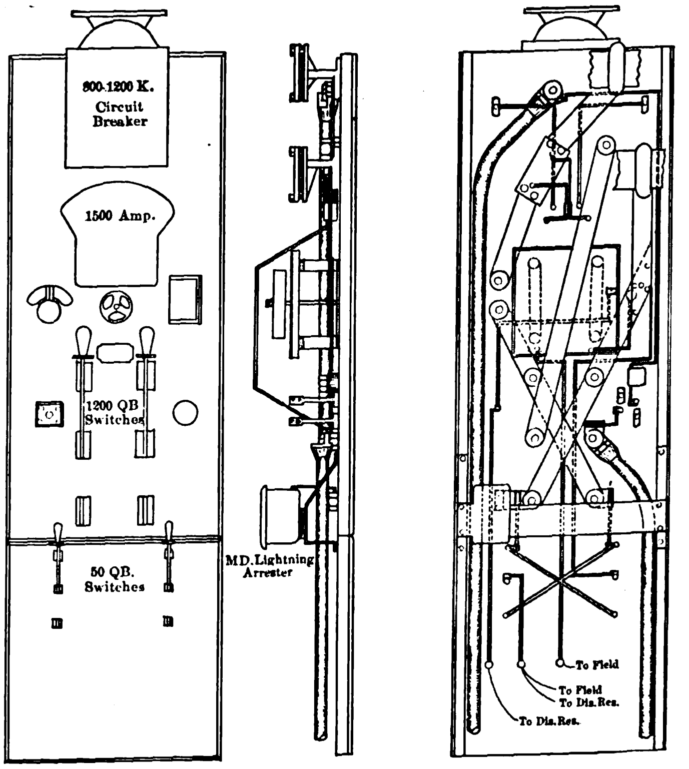


FIG. 18—ROTARY CONVERTER PANEL, D. C. SIDE.

Substation Switchboard.—The switchboards for the three substations will consist of ten blue Vermont marble panels, divided into three units, two having two alternating and two direct-current panels, and the other, one alternating and one direct-current panel. Fig. 17 shows the connections of the rotary converter panels, alternating current slide; and Fig. 18 direct-current side.

Each of the alternating panels will be fitted with the following apparatus: One 650-volt, inclined coil, dead-beat, voltmeter; one 1500-ampere, inclined coil, dead-beat ammeter; one pilot lamp; one potential plug; six single-pole quick-break switches. On the back will be one current transformer for ammeter, and the necessary busbars.

Each continuous current panel will be equipped with the following apparatus: One 800-1200 circuit breaker; one 1500 ampere, illuminated dial Weston ammeter; one generator rheostat; one lightning arrester; two single-pole, double-throw, main switches; one lightning switch; one potential plug; one pilot lamp; one two-way field switch; one resistance lamp; one illuminated dial Weston voltmeter, reading 750 volts each side of zero, mounted on a hinged bracket beside panel; two single-pole, double-throw field switches on sub-base.

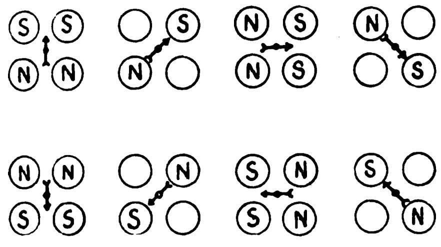
Each D.C. panel is provided with an automatic cutting-out device for the purpose of protecting the rotaries in case of reversal of current. It is so aranged that if the current on the direct-current side of the rotaries is reversed, the circuit breaker will be automatically thrown out.

The hydraulic work of the plant was constructed by local contractors, supervised by Mr. William de la Barre, engineer of the company. The electrical work was in charge of Mr. Edward P. Burch.

THE INDUCTION MOTOR.

BY ALFRED E. WIENER, E.E., M.E.

Though the induction motor has passed into its practical stage but a short time ago, the discovery of its principle dates back about seventy-five years. It was during 1822 and 1823, when engaged in magnetic observations, that Arago observed that the needle of one of his compasses, which was mounted upon a copper base, came to rest much sooner than other ones which had ordinary wooden cases. He reasoned that some force, unknown to him, was the cause of this behavior, and, arguing from the principle of action and reaction, he succeeded, in 1824[1], in deflecting and even dragging into rotation a magnetic needle suspended over a revolving disc of copper.



FIGS. 1 TO 8.—BAILY'S ROTARY FIELD, PRODUCED BY VARIOUS MAGNETIZATIONS OF FOUR ELECTROMAGNETS.

In 1825 Babbage and Herschel, two English experimenters, reversed Arago's arrangement, and showed that the revolvable copper disc can be set in motion by spinning beneath it a strong magnet.

Six years later (1831) Faraday proved that the rotation of the magnet in Arago's experiment, and of the copper disc in the Babbage-Herschel arrangement, was caused by the reaction of electric currents produced in the copper disc by electro-magnetic induction; for, when revolving the copper disc between the poles of a stationary magnet, he was able to collect electric currents by means of sliding contacts placed against the center and periphery of the disc, respectively. Although the latter arrangement, familiar by the name of "Faraday's Disc," soon led to the construction of the magneto-electric, and, subsequently, of the dynamo-electric machine, it was not until 1879 that the next important step toward the invention of the induction motor was taken.

In the year above named, Walter Baily[2] demonstrated by experiment that Arago's copper disc may be set into rotation, not only by spinning a permanent magnet bodily, but by revolving instead the *magnetic field* produced by a number of electro-magnets. He used four comparatively long vertical cores, which, by means of a special commutating switch, he successively magnetized, as shown in Figs. 1 to 8, so as to obtain a *rotary magnetic field*.

In Baily's motor continuous currents were used to excite the electro-magnets, but in 1883 it was shown by Marcel Deprez that a true rotary field can be produced by the combination of two alternating currents having a difference of phase of a quarter period.

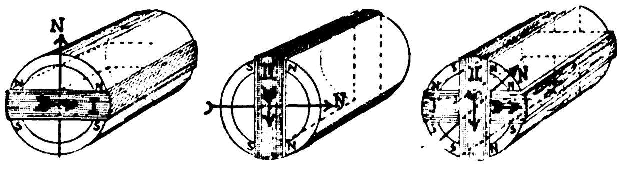
In 1885 Prof. Galileo Ferraris independently constructed a motor in which rotation of a copper cylinder was caused by currents induced in it by a progressively shifted magnetic field, the latter being produced by two-phase alternating currents.

The principle of the induction motor thus having been fully established, it remained to work out its parts so as to obtain a commercial machine of high efficiency. This task was accomplished by Nikola Tesla, who, during the years 1886 to 1891, took out a series of important patents (now owned by the Westinghouse Company, Pittsburgh, Pa.); by M. von Dolivo-Dobrowolsky, 1887 to 1891 (Allgemeine Electric Company, Berlin, Germany); by Haselwander, 1887 (W. Lahmeyer & Company, Frankfort, Germany); by Charles S. Bradley, 1887; by Charles P. Steinmetz (General Electric Company, Schenectady, N. Y.); by Wenström (1890), and numerous others.

The modern induction motor thus developed is in the following, discussed under four headings:

I. Principle of Rotary Magnetic Field.

II. Structure of Induction Motor.



FIGS. 9, 10 AND 11.—MAGNETISM SET UP BY HORIZONTAL AND VERTICAL COIL.

III. Induction Motor Field Winding.

IV. Induction Motor Armature Winding.

In Part I. the production of a rotary field by polyphase alternating currents is shown; in Part II. the principal parts of the practical motor are treated; and under III. and IV., the various modes of winding and connecting of induction motors will be given.

I. PRINCIPLE OF ROTARY MAGNETIC FIELD.

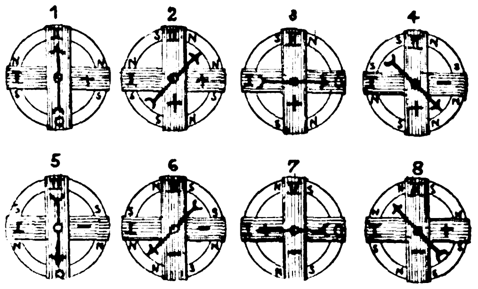
If two or more coils are arranged around an iron core, the magnetism set up in that core by currents passing through the coils is the resultant of the magnetizations due to each coil separately. Thus when the two equal coils, I. and II., Figs. 9 and 10, which, when traversed by equal continuous currents in the directions indicated by arrows, cause a vertical and a horizontal magnetization, respectively, are combined upon one core, as shown in Fig. 11, the direction of the resultant magnetization makes angles of 45 degs., with both the former directions. This can easily be seen from the polarity of the iron core, as marked in Figs. 9, 10 and 11.

If alternating currents, differing in phase from each other—that is to say, currents of equal frequency and value, but not reaching their zero value at the same time—are sent through these coils, the direction of their resultant magnetism is not constant, but varies continually, and thus a *rotary magnetic field* is obtained. In order to prove this, let us consider the conditions necessary to establish a rotating magnetic field by means of continuous currents. Since the polarity due to any coil is reversed by the reversal of the current in that coil, it is evident that a rotating magnetic field can be obtained by means of coils I. and II., if the following changes are made successively:

	Current Through Coil I.	Current Through Coil II.	Direction of Resultant Magnetism.	
1.	+	0	0	Fig. 12
2.	+	+	45	" 13
3.	0	+	90	" 14
4.	—	+	135	" 15
5.	—	0	180	" 16
6.	—	—	225	" 17
7.	0	—	270	" 18
8.	+	—	315	" 19
1.	+	0	360	" 12

Now let us plot two alternating currents differing in phase, Fig. 20.

It will be seen that exactly the above eight conditions exist in each complete cycle. At point 1, the current I (flowing through coil I) has a + value, while current II (in coil II) just passes through the zero-line. From point 1, the current II gradually rises while I decreases until at point 3 it is zero, while II still has a + value; between points 1 and 3, therefore, the condition 2 exists, namely, both I and II are positive. At point 5 current II has become 0, while I is, —, and between 3 and 5 there are various stages of condition 4. Between 5 and 7 both currents have — values, corresponding to condition 6. At 7, current I is 0, and II is —, and from 7 to 1 the — value of II gradually changes to 0, while *I* rises in + values; hence, between 7 and 1 there exists condition 8, while at 1, the original condition is again attained and the cycle begins anew. Thus we see that two alternating currents, differing in phase from each other, when sent through the two coils, cause a revolving magnetic field, the advantage of the alternating over the continuous current being, besides, that the changes from one direction to the next are not sudden, but gradual, thus insuring a more uniform motion of the rotating magnetic field.



FIGS. 12 TO 19.—COMBINATION OF TWO CONTINUOUS CURRENT COILS, PRODUCING ROTARY MAGNETIC FIELD.

A true rotary motion of the resulting magnetism is also obtained in the case when three coils traversed by three alternating currents, differing in phase by 120 degs., are combined upon one core. Plotting three such currents, I, II, III, Fig. 21, we find that there are twelve easily distinguishable points in each cycle, for which the respective conditions are as given in the following table:

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[1] Before the Academy of Science, Paris, Nov. 22, 1824.

[2] "A Mode of Producing Arago's Rotation," paper read before Phys. Soc., London, June 28, 1879.

Point.	Polarity of Current in			Currents Equal in Coils.	Direction of Resultant Magnetism.	
	Coil I.	Coil II.	Coil III.			
1	0	—	+	II and III	0°	Fig. 24
2	+	—	+	I " III	30	" 25
3	+	—	0	I " II	60	" 26
4	+	—	—	II " III	90	" 27
5	+	0	—	I " III	120	" 28
6	+	+	—	I " II	150	" 29
7	0	+	—	II " III	180	" 30
8	—	+	—	I " III	2 0	" 31
9	—	+	0	I " II	240	" 32
10	—	+	+	II " III	270	" 33
11	—	0	+	I " III	300	" 34
12	—	—	+	I " II	330	" 35
1	0	—	+	II " III	360	" 24

The magnitude of the two equal currents at points 1, 3, 5, 7, 9 and 11 is, by Fig. 22,

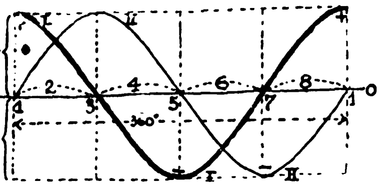


FIG. 20.—TWO ALTERNATING CURRENTS DIFFERING IN PHASE BY 90 DEGS.

$$X = I \times \sin 60^\circ = .866\ I,$$

or .866 of the maximum value, *I*, of the current intensity, while at points 2, 4, 6, 8, 10 and 12 the equal currents in the two coils, according to Fig. 23, have the strength:

$$Y = I \times \sin 30^\circ = .5\ I,$$

or ½ of the maximum current at that time flowing in the third coil.

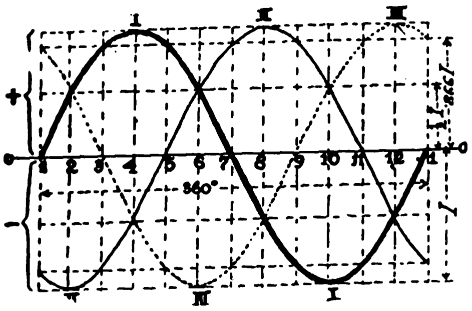
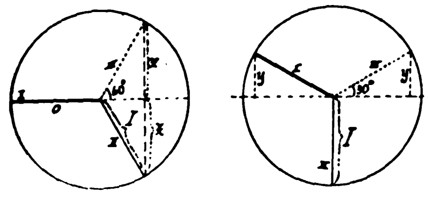


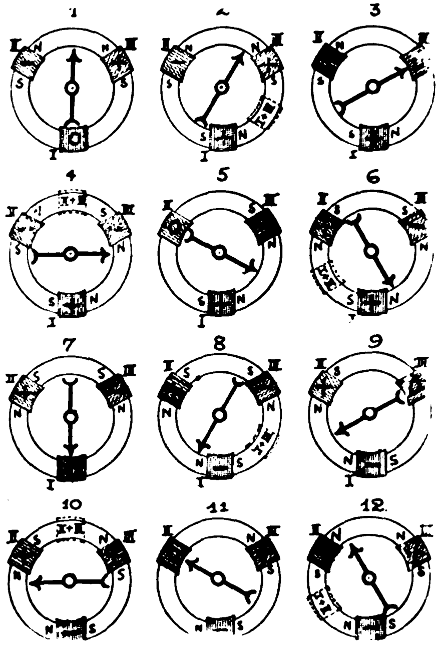
FIG. 21.—THREE ALTERNATING CURRENTS DIFFERING IN PHASE BY 120 DEGS.

The magnetizations due to the separate coils and the direction of the resultant magnetization for these twelve points are shown in Figs. 24 to 35.

In Fig. 24 the current in coil I is 0, that in coil II is —, and in coil III is +. Assuming that a + current in any coil causes a magnetic flux through the core in the counter-clockwise direction, both the north-poles due to coils II and III are directed upward, and the resultant magnetism has a vertical direction, or 0°. In Fig. 25, the currents in coils I and III, as can be seen at point 2, Fig. 21, are both +, are equal to each other, and are each of one-half the strength of the — current flowing in coil II. The dotted coil, placed half way between I and III, and having equal magnetizing strength to coil II, can therefore be considered as representing the combined magnetism of coils I and III, and the direction of the resultant magnetism of the three coils is found to be perpendicular to the diameter indicating the position of coil II, that is, 30 degs. in advance of the vertical line. All the other directions of the resultant magnetism are determined similarly to the cases of Figs. 24 and 25, respectively. Thus, in Figs. 26, 28, 30, 32 and 34, corresponding to points 3, 5, 7, 9 and 11, two coils only being active, the resultant magnetism has a direction coinciding with the position of the third or neutral coil; and in Figs. 27, 29, 31, 33 and 35, corresponding to points 2, 4, 6, 8, 10 and 12, one coil being traversed by a current of one polarity, and the remaining two by currents of half the strength but of the opposite polarity, the resultant magnetism has a direction perpendicular to the diameter marking the position of the coil of largest current-strength.



FIGS. 22 AND 23.—RELATIVE STRENGTH OF CURRENTS IN THREE COILS OF A THREE-PHASE SYSTEM.



FIGS. 24 TO 35.—DIRECTION OF RESULTANT MAGNETISM DUE TO THREE ALTERNATING CURRENTS DIFFERING IN PHASE BY 120 DEGS.

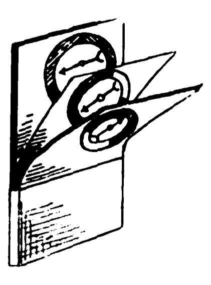


FIG. 36.—KINETOSCOPE, SHOWING MOTION OF ROTARY FIELD.

An excellent way to show the motion of a revolving field, both for the lecture-room and for home study, is to prepare small sheets of paper, each containing one of Figs. 12 to 19 for a two-phase field, and of Figs. 24 to 35 for a three-phase field (simplified, if desired, by omitting the coils themselves, and only indicating their polarity by different colors) and to unite, in the proper rotation, and exactly concentric with each other, a number of these sheets covering two or three cycles into the form of a "kinetoscope," as shown in Fig. 36. When passing the sheets in one way the revolving field will be seen to rotate in one direction, while, when moving the sheets backward, the rotation of the magnetic field is in the opposite direction, showing that the reversal of the order of the coils has the effect of reversing the rotation of the magnetic field.

◆

ERECTING A HIGH VOLTAGE TRANSMISSION LINE.

BY S. H. DAILEY.

In this article the writer intends to give detailed instructions for the erection of a transmission line, and to that end will take all of the operations into consideration, supplementing them with illustrations taken from actual work upon a line, and also with such drawings as are necessary to fully describe the work.

The conditions of an assum[illegible] line will be dealt with, and a general idea of the requirements of the work will be roughed out in a set of specifications. These specifications are merely in a skeleton form to fit the conditions of this example.

Specifications.—Poles are to be [illegible] 5 ft. in the ground, 90 to 110 ft. apart in line and 80 to 90 ft. on curve. They are to be of an average height of 36 ft., with a minimum diameter of 7 ins. at the top and 14 ins. at the ground line.

To carry four conductors, 18 ins. apart, on a 5-ft. cross arm, and on peak of pole 15 ins. from top arm, to run the entire length of the line, a barb wire, which is to be grounded every half mile.

A second gain 18 ins. from top of first gain is to be cut at time of erection.

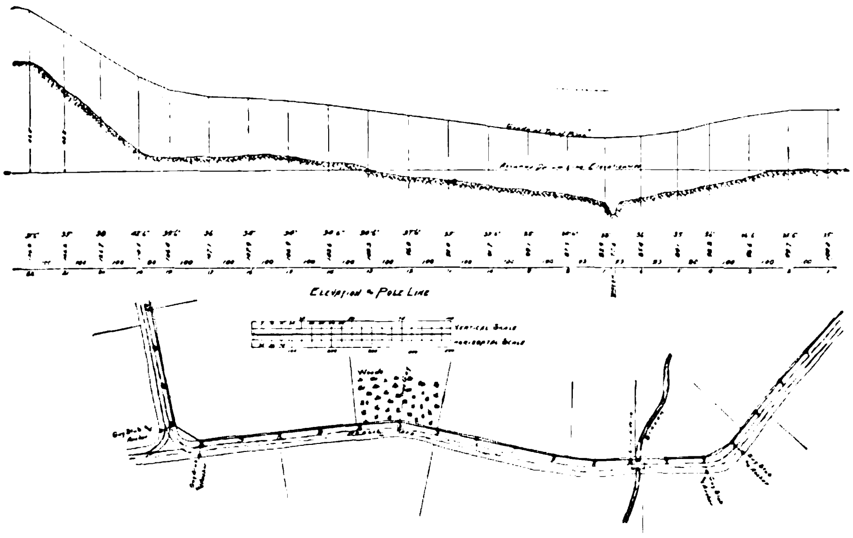
Cross arms are to be fastened to poles by two 7 in. x ½ in. lag bolts, which must be screwed into the pole—not driven. To further secure the cross arm, it must be braced with iron braces 1¼ in. x ¼ in., secured to the cross arm with ⅜ in. bolts and to the pole by 3 in. x ½ in. lag bolts. All bolts and braces to be thoroughly galvanized.

Six ft. below the top gain is to run a telephone line—metallic circuit—supported by brackets, one on each side of the pole. All poles, where the line makes a deviation from a straight course at an angle greater than 10 deg., are to be securely guyed or anchored.

Locating the Line.—The most desirable and cheapest to erect and maintain is an air line between the power house and the point of distribution. However, circumstances will not allow this, and the conditions may compel following the public road. Having decided upon the route the line is to take, the first operation is to "peg it out" by placing a peg to indicate where the poles are to be set.

Before driving any pegs, the route should be gone over and a definite decision made as to which side of the road is to be used, a rough sketch being made at the time for future reference, taking into consideration that the line should follow that side which will require the least tree trimming, and also avoiding crossing any more public roads than absolutely necessary.

The tools and implements to begin with will be a 100-ft. measuring line (a steel tape divided into feet and tenths of a foot will be found the most convenient, as the decimal parts of a foot can be handled easier in calculating than inches and fractional parts); one hand axe; two white muslin flags, 2 ft. x 3 ft., fastened to the ends of 12 ft. pine sticks 1 in. square, the other ends being pointed so as to be easily stuck into the ground; one stick 1 in. square 5 ft. long; a piece of chalk or lead to number the pegs as they are placed. The peg can be made of pine or hemlock, 18 ins. long, 1½ ins. square and pointed at one end.



FIGS. 1 AND 2.—ELEVATION AND PLAN OF POLE LINE.

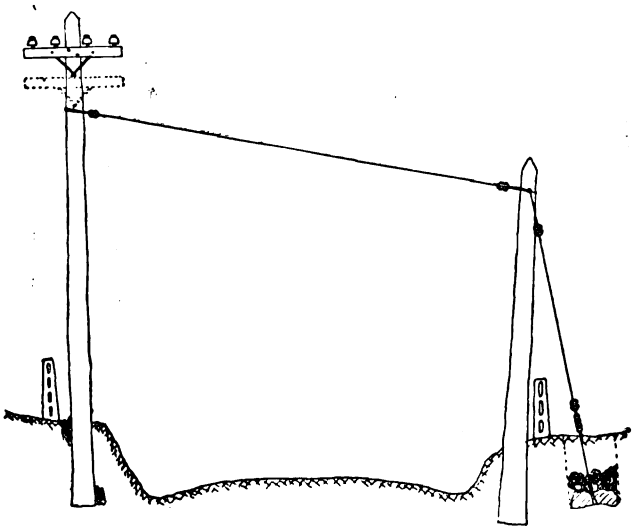


FIG. 3.—GUY STUB AND ANCHOR.

It must be held continually in mind that the straighter the line the cheaper will be its maintenance.

Fig. 2 is a plan of the pole line, assumed for illustration only, and showing a public road with a transmission line running along one side; it also gives an idea how to make a permanent plan of the line for reference which, since it will be found useful for consultation in more ways than one, should be made as carefully as possible with respect to the distances and courses of the road.

It will not be necessary to use an instrument to line up the pegs, as the eye is sufficiently accurate in conjunction with the flags.

Beginning at pole No. 1, measure off as many 100 ft. lengths as thought convenient—say in this case to a turn in the road, which is position of No. 4—and drop a peg at each mark. Now have the helper place his flag in the position where No. 4 is to be located with regard to the fence and road gutter, and return to No. 1. Hold the 5-ft. stick on No. 1 peg driven home, and sight between the stick and flag. In this case we find that a straight line connecting these will come too far into the road at an intermediate point, say No. 2, so the helper moves to No. 2 with the flag and there places a peg the same distance from the fence as No. 1. This is No. 2, and the distance and number of peg noted in first and second columns of a note book ruled like Table I, to be used later in plotting the elevations for grades.

Next, have the helper place one flag where No. 4 is to go, and place the stick on No. 2; the helper, taking the other flag, goes to No. 3, and his flag is lined with the stick held on No. 2 and the flag at No. 4. Pegs Nos. 3 and 4 are driven and numbered, and the distance put down in note book. Going then to flag No. 4, it will be found easier to turn on two poles than one, the angle being thus divided up not being short enough to require a reverse turn, which will be described later.

For this turn it will be better to shorten the distance between poles to 80 ft., thus taking some strain and weight from the poles and not going too far into the fields.

Having decided on the location of No. 5, a straight line takes us to where No. 8 stands, which, being measured, is 279 ft. This will give three poles at 93 ft. distance between poles 5 and 6, and 6 and 7, 7 and 8; this distance will answer, but it is better not to go below 90 ft. or over 110 ft. in a straight line. In this instance it suits the conditions very well as there is a stream of water near No. 7 which will be good for a ground wire.

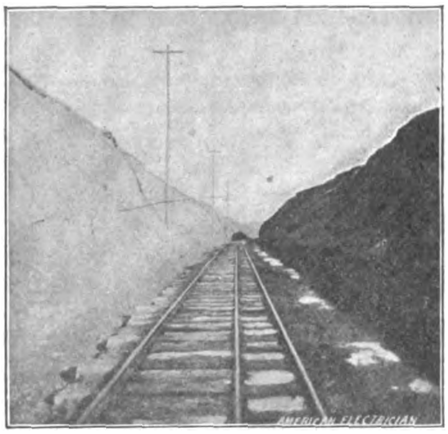


FIG. 4.—LOCATING POLES IN A RAILROAD CUT.

Fig. 3 is an elevation of a guy stub and anchor, showing the manner of locating poles relative to fences and road gutters; the latter must be kept away from, for otherwise not only will the authorities object, but during a rainy spell water will be continually washing around the pole, tending to loosen it and throw it out of line.

Referring to Fig. 2, which gives a plan of the line, poles 4, 5, 18 and 19 will need to be guyed and anchored; pegs showing the position of the guy stub and anchor should be driven at these points. In placing a guy stub, locate it so as to divide the angle which the line makes at that point.

Fig. 4 shows the manner of locating poles in a railroad cut, and Fig. 5 shows part of a transmission line, where the conditions are severe as to curves.

Grading.—Having finished laying out the line, the next operation is grading it, in order to determine the length of poles needed at each peg, so as to have an easy grade in the wire, thereby distributing the strain evenly on all poles.

Fig. 1 is an elevation of the pole line, and shows a profile as pegged out, the elevations being taken at each peg. To work this out there will be needed a level, a 16-ft. pole ¾ x 1½ in., divided into feet, and each foot divides into 10 spaces, which will be 1-10 of a foot or decimal, .1.

AMERICAN ELECTRICIAN

FIG. 5.—CURVES OF POLE LINE.

A convenient form of keeping notes is given in Table I. This table shows that the distance between poles 1 and 2 is 100 ft., which was marked down when "pegging" out. Setting the level in a convenient position, place it between poles 1 and 2 so that the line of sight will fall above the ground at these points. Have the helper hold the measuring stick at peg 1, take a sight at it and put down in the book under the column of "Back Sights" on line with No. 2, the height—say in this case, 5.2 ft. The helper now goes to peg 2 and holds the stick on it while another sight is taken at it, the level of the instrument not having been changed; this result is placed down under column of "Front Sights"—say 5.5 ft. The operation is the same for each succeeding space.

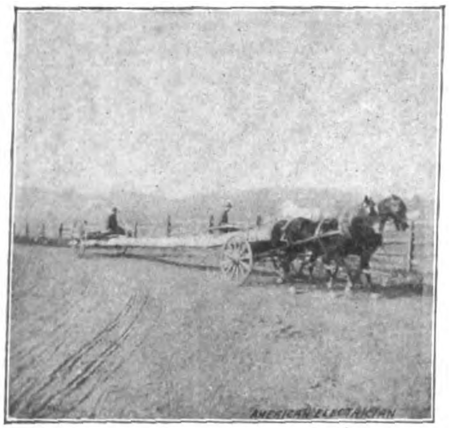


FIG. 6.—HAULING POLES.

It will be noticed here that the difference between the two readings is .3 ft.; the front sight being the larger, it follows that No. 2 is .3 ft. lower than No. 1, which .3 is placed in the column of "Fall." Being careful to place the back and front sights in the proper column, and noticing that the difference between them is always on the side of the greater, a mistake can hardly occur.

In Table I, between poles 6 and 7, will be noticed a reading which is the bed of the stream; this was taken while getting the elevation of 6 and 7 merely as an aid in plotting the profile, and does not come in with the additions in checking up the table. Between poles 19 and 20, 20 and 21, the rise was too great to admit of one reading, so it was divided in two, as the table will show.

TABLE I.—NOTE FORM.

Pole.	Distance.	Rise.	Back sight.	Front sight	Fall.	Elevation.	Remarks.
1						100.0	
2	100	—	5.2	5.5	.3	99.7	
3	100	—	4.4	7.5	3.1	96.6	
4	100	—	2.7	7.1	4.4	92.2	Stub Guy and Anchor
5	80	—	3.5	6.6	3.1	89.1	Stub Guy and Anchor
6	93		4.0	11.2	3.7	85.4	
			3.4	1.2	7.8	77.6	Stream
7	93	—	3.4	5.9	2.5	82.9	Ground Wire
8	93	4.6	8.0	3.4	—	87.5	
9	100	1.6	6.0	4.4	—	89.1	
10	100	2.6	6.4	3.8	—	91.7	
11	100	2.7	6.5	3.8	—	94.4	
12	100	1.6	6.0	4.4	—	96.0	
13	100	4.3	6.5	2.2	—	100.3	Tree Guy
14	100	3.3	7.8	4.5	—	103.6	
15	100	3.3	6.5	3.2	—	106.9	
16	100	1.0	6.1	5.1	—	107.9	
17	100	—	4.1	4.9	.8	107.1	
18	100	—	4.9	5.6	.7	106.4	Stub Guy and Anchor
19	80	4.1	5.6	1.5	—	110.5	Stub Guy and Anchor
		7.5	8.5	1.0	—	118.0	
20	100	8.7	9.7	1.0	—	126.7	
		8.7	10.0	1.3	—	135.4	
21	100	6.8	8.3	1.5	—	142.2	
22	100	13.8	14.5	.7	—	156.0	
		74.0	148.6	92.6	18.6		
		18.6	92.6				
		56.0	56.0				

Having finished running the levels, check the table to see that the readings were placed in their proper columns. Add up the columns "Rise," "Back Sight," "Front Sight" and "Fall"; then if the work is right, the difference between "Rise" and "Fall" should be equal to the difference between "Back" and "Front" sights. If such is the case, then deduce the elevation of each point as follows:

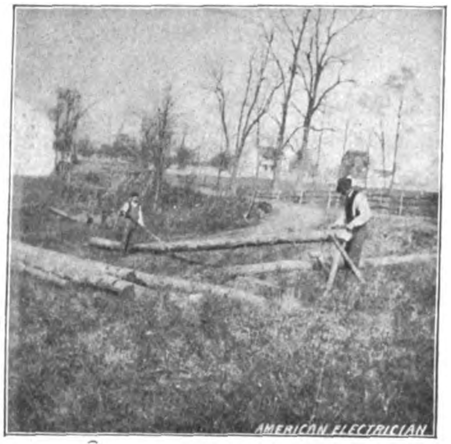


FIG. 7.—GAINING POLES.

Assume a datum of sufficient elevation that the lowest point will not go below *o*; in this case 100 is used, being the elevation of peg 1. No. 2 is in the Fall column by .3 and must be subtracted from 100, giving 99.7 ft.; place this in column marked "Elevation." No. 3 is again lower by 3.1 ft., which gives 99.7 — 3.1 = 96.6 ft., and so on; finally, the elevation of No. 22 above No. 1 is 156.0 — 100.0 = 56 ft., which it will be noticed, is the difference between the "Back" and "Front" sights, the stream elevation not being counted. The levels or elevations being reduced, the surface line may be represented in the form of a section as in Fig. 1.

The vertical and horizontal scales of a section are seldom the same, which produces a caricatured representation; the vertical scale being so much greater than the horizontal, shows the grade with greater clearness than if both scales were the same. The original scales used in this section are, vertical 1 in. = 20 ft.; horizontal, 1 in. = 100 ft.

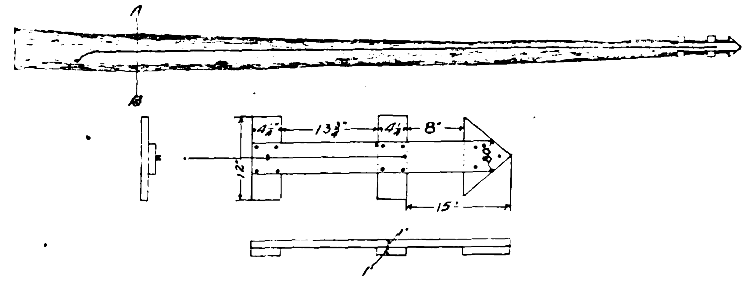
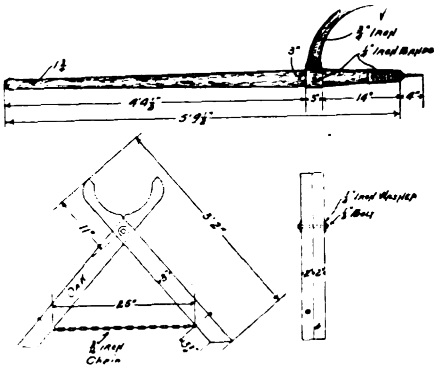


FIG. 9.—GAINING TEMPLATE.

To make the section in this example, first draw the horizontal or assumed datum line, representing 100 as the datum to which the elevations were reduced. On it mark off the distances between pegs corresponding to column headed "Distances;" number the pegs below the datum line, putting down the distances between these numbers. Above the distances, vertically, put the height of the surface of the ground from column of elevations for each peg.

At peg 2 let fall a perpendicular from the datum line, and on it mark off the fall, .3 ft., which is the level of the ground at this point; in like manner proceed with each succeeding peg, being careful to note whether it is a rise or fall. Now the lines connecting these points represent the elevation on the ground of the pole line, and the section is now ready to plot the grade of the wire or top of poles.

In drawing the grade line, set up at different points perpendicular lines, representing poles, of the average height decided upon—this case 36 ft., allowing 5 ft. in the ground, and connect the tops with a line, being careful not to have any sharp vertical curves in it. To this grade line erect perpendiculars at each peg, which will be the length of pole required. Measure them with the scale, allowing 5 ft. to be in the ground and place the height of each over the elevation figures at the bottom. Add together the length of all the poles, divide the sum by the number of poles and see whether this result will bring you within the average height; if not, the grade line must be dropped toward the datum line to accomplish the desired result.



FIGS. 7 AND 8.—CANT HOOK AND POLE BUCK.

A very convenient paper to work out a profile on can be had from any engineering supply house. It is ruled to a scale of 4 divisions to the inch horizontally, and 20 to the inch vertically, and called profile paper.

The problem has now assumed such shape that the poles can be cut and distributed at the proper pegs. In distributing poles, see that all the tops are laid up hill with butt near the peg, as this will save much time in raising. Fig. 6

shows the manner of loading poles, and Fig. 7 the operation of gaining and trimming. The necessary tools and implements for gaining are as follows:

A small pole buck, Fig. 8; cant hook, Fig. 7; broad wood chisel; foot adze; hatchet; saw; paint pot, brush and paint; gaining templet, Fig. 9.

It will require two men at this work, and they should be started as soon as the poles are laid out so the raising gang can go on without having to wait for gaining. On the position of the gain in a pole depends a great deal. First, it must be cut in such a place and way that when the cross arm is put on it will set parallel with the ground; second, it must be put on that part of the pole which will allow the greatest bend to run with the line and not at right angles to it, thus making a far prettier looking line; third, the gains must be cut so as to allow of a snug fit of the cross arm, thereby helping to keep the weather out and insuring longer life of cross arm and pole.

To decide on the proper place to cut the gain, roll the pole till the greatest crook or bend is down next to the ground; now the gain must be cut on the side directly opposite, or that part turned up; this, as will be seen, puts the greatest bend in line, in which position the line strain will be better and the crookedness will only show from a side view.

Fig. 9 shows the gaining templet and the manner of placing it on the pole, so that the cross arm will set horizontally. By means of such a template, and following the method given below for using it, a pole line may be erected that will give every satisfaction.

The templet, as will be noticed, is arranged to mark off the peak and two gains. The peak will be 15 ins. from the top of the first cross arm, and the cross arms 18 ins. apart, thus allowing the line wires to be 18 inches apart in all directions, as the pins are also set 18 in. apart. On the templet there should be a string attached to the top of the first gain mark, passing between two nails at or near the bottom of templet and exactly in the center. Place the templet upon the pole, after having the pole in position as above described, so that the string will be in the middle of pole at that piont. Now, have the other end of the string held in the center of the pole 5 ft. from the butt, or where the level of the ground meets the pole when it is set on line *AB*; then move the templet until the string falls in between the two nails on the bottom gain, when the templet will be set to mark gains and peak.

Saw the gains 1 in. deep, chisel out smooth and cut the peak according to marks; paint well all parts cut. Knots and bumps should be trimmed off smooth with the adze.

A concluding article will deal with the digging, raising and setting of the poles, guying and anchoring the same and stringing the wires, and will give detail instructions for the work; also the necessary tools, and the amount of work capable of being done with a certain number of men, whereby an approximate idea of the cost of labor on a line can be had.

ARMATURE WINDINGS AND CONNECTIONS.

BY PROF. ARTHUR L. RICE.

PLAIN AND FORCED TWO-CIRCUIT WINDINGS.

The Gramme ring winding of the two circuit form, unlike the multiple connection, is not available for any number of poles, but must be connected especially for a given number of poles. For instance, if the armature of Fig. 1 (Fig. 6 of the April issue) is to be used in a six-pole machine, the condition to be fulfilled will be: $2 \times 11 + 2 = 6 \times$ pitch; $22 + 2 = 24 = 6 \times$ pitch; pitch $= 4$. There is no alternative, because $22 - 2 = 20 = 6 \times$ pitch, and 20 is not divisible by 6. The connections would then be as follows:

Bar	to conductor	to bar	to conductor	to bar	to con'r.
10	I.	3	V.	7	IX.
11	II.	4	VI.	8	X.
1	III.	5	VII.	9	XI.
2	IV.	6	VIII.	10	I.

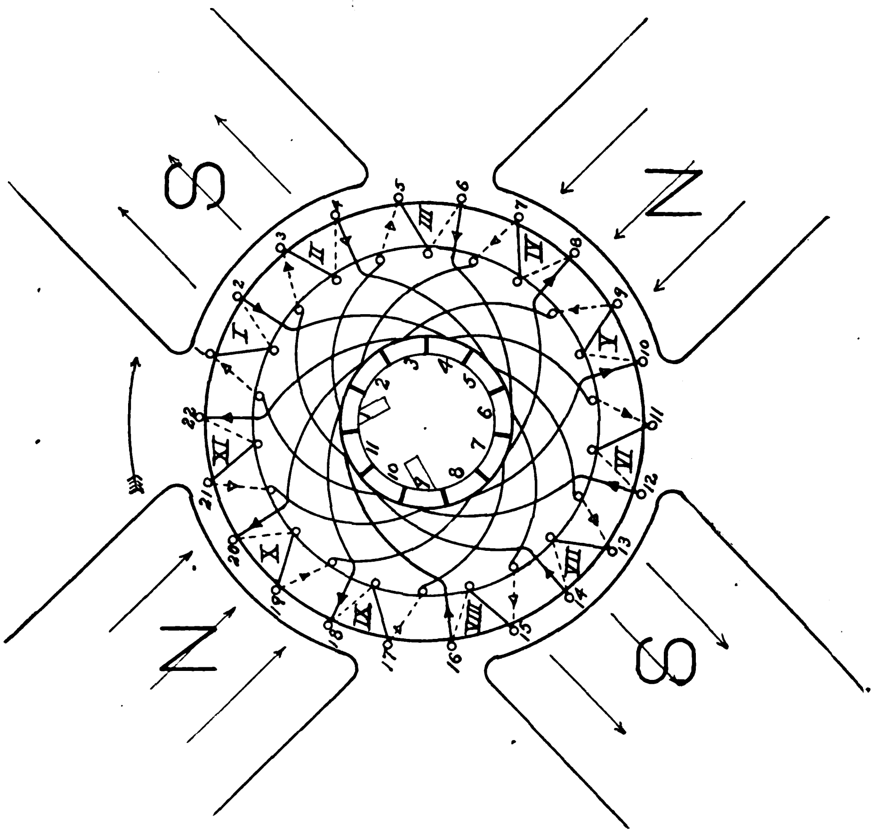


FIG. 1.—FOUR-POLE TWO-CIRCUIT GRAMME RING WINDING.

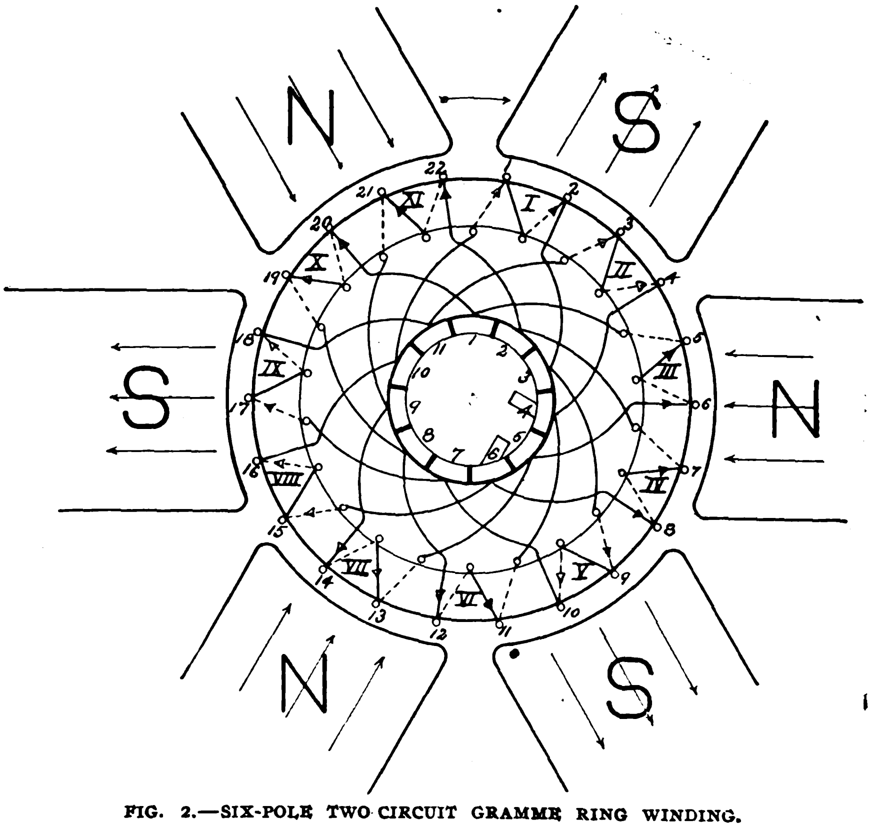


FIG. 2.—SIX-POLE TWO CIRCUIT GRAMME RING WINDING.

The brushes would go on bars 4 and 6 as shown in Fig. 2. The conductors are, as in Fig. 1, connected into two circuits, and there is the same unbalancing. The brushes are, of course, nearer together on the commutator than in Fig. 1—much nearer than would be allowable in practice. This would take care of itself in a properly designed machine, since the number of bars and coils—here shown absurdly small, for the sake of clearness in the diagram—would be greatly increased.

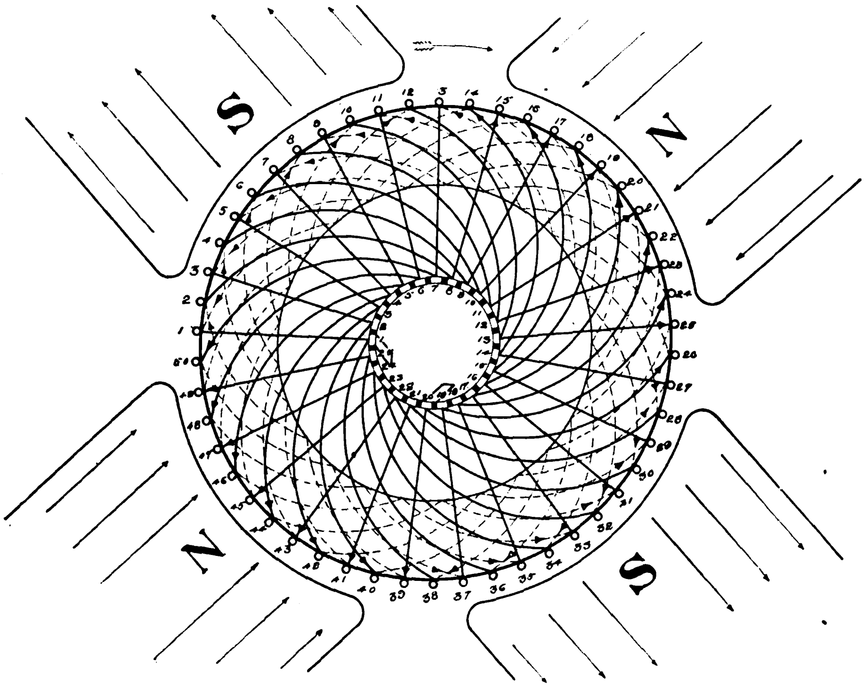


FIG. 3.—FOUR-POLE TWO-CIRCUIT DRUM WINDING.

In the case of drum armatures, the wave winding is the only form used for two circuit connections; hence the equation of condition for wave windings must be always satisfied; that is, number of conductors—number of circuits = number of poles × average pitch. Suppose it be desired to wind up 50 conductors into a two-circuit armature for a 4-pole dynamo. 50 — 2 = 4 × pitch; 48 = 4 × pitch; pitch = 12 or 52 = 4 × pitch; pitch = 13. Using 12 will give a retrograde winding, dropping back one bar on the commutator at each two connections; 13 will give a progressive winding, advancing one bar at each two connections. Let 13 be chosen; then connections will be from bar 1 to conductor 1, to conductor 14, to bar 14, to conductor 27, to conductor 40, to bar 2, to conductor 3, and so on, as shown in Fig. 3. The brushes are found to belong on bars 1 and 20, and are at 25 ÷ 4 = 6¼ bars apart. In passing from bar 1 to bar 2, the one adjacent, four conductors are joined up; as there are 6¼ bars between brushes, there will be 6¼ × 4 = 25 conductors between brushes. This is half the conductors on the armature, therefore the winding is a two-circuit winding. This method of testing is always a good one to ascertain whether a proposed winding fulfills the required condition as to the number of circuits in parallel. The unbalancing noted in the case of Fig. 1 and Fig. 2 is present here, but, as there, it will not be sufficient in a commercial armature to do any harm.

Suppose it is desired to wind the same armature for a six-pole machine. 50 — 2 = 6 + pitch; 52 or 48 = 6 × pitch; the average pitch must be 8, as 52 is not divisible by 6. Let the windings be in two layers, as is common in commercial work. Then, since the odd-numbered conductors are all in the outside layer and the even-numbered ones in the inside, it will be impossible to pass from one layer to the other with an even number for actual pitch, since the sum of an odd number and an even number is always odd, and of two even numbers always even.

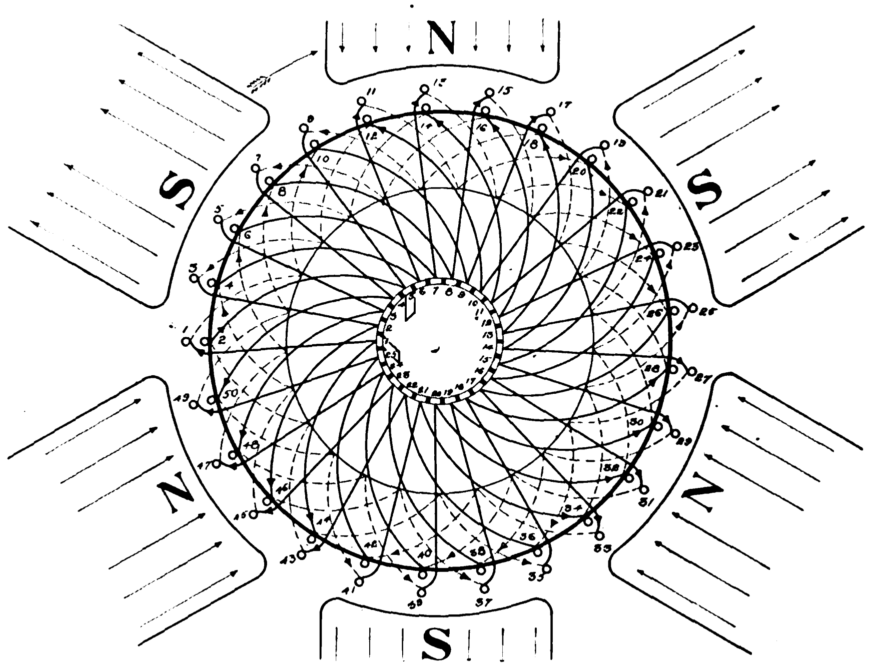


FIG. 4.—SIX-POLE TWO-CIRCUIT DRUM WINDINGS.

It is desirable to connect an outside conductor to an inside conductor to form a coil for the sake of symmetry and easy winding; therefore, it will be necessary to use unequal odd values for front and back pitch, such that the average shall be 8. Take 7 for the front and 9 for the back; then bar 1 connects to conductor 1, then on back to conductor 10, on front to conductor 17 through bar 9, on back to conductor 26, on front to conductor 33 through bar 17, on back to conductor 42, on front to conductor 49 through bar 25, and so on, as shown in Fig. 4. The brushes go on bars 1 and 5 at 25 ÷ 6 = 4 1-6 bars apart. In going from bar 1 to 25, which is next it, there are joined in 6 conductors; 6 × 4 1-6 = 25, or half the conductors on the armature are in one path between the brushes and there will be two circuits as intended. The unbalancing always brought in by connecting as a two-circuit winding is present, but otherwise the winding fulfils the requirements.

Since the two-circuit winding is to be used in order to allow of running high voltage machines at a low speed, it is desirable to be able to use the same parts for both high and low voltage machines. With a smooth-bodied armature core there is no difficulty in winding any number of conductors for which there is room on the armature; and the field coils can be wound of such size wire as will give a resistance suitable for the voltage to be used. But it is not possible to use the same commutator for parallel and series winding unless some of the bars are short-circuited so that the number of bars in use will correspond to the number of coils used.

With a toothed armature the problem is more complicated. The number of coils is regulated by the number of slots and cannot be changed; but one or more of the coils may be left unused. Suppose that it is desired to wind a toothed Gramme ring armature with 24 slots and bars into a two-circuit armature for a four-pole machine. By the condition given in the April number: 2 x 24 + 2 = 4 x pitch; 50 or 46 = 4 x pitch. This will not do, as neither 50 nor 46 is divisible by 4. If, however, one of the coils be left unused, then: 2 x 23 + 2 = 4 x pitch; 48 or 44 = 4 x pitch; and pitch = 12 or 11. Let 11 be chosen. One coil and one bar will have to be left unused. The unused, or "dead" coil, is wound in place to give mechanical balance, but is left with one or both ends unconnected. The unused bar is short circuited to the one adjoining, so that there shall not be a break in the circuit as the brushes pass that bar. The coil which would be number 24 is chosen (Fig. 5) for the dead coil; the dead bar must be one of those which would have connected to coil 24 in the winding; in Fig. 5 one end of the dead coil is shown connected and the bar to be made dead is thus determined; the other end of the coil is bent back on itself and covered with insulation. For the sake of short leads, coils which are to be joined are connected to a bar half way between them.

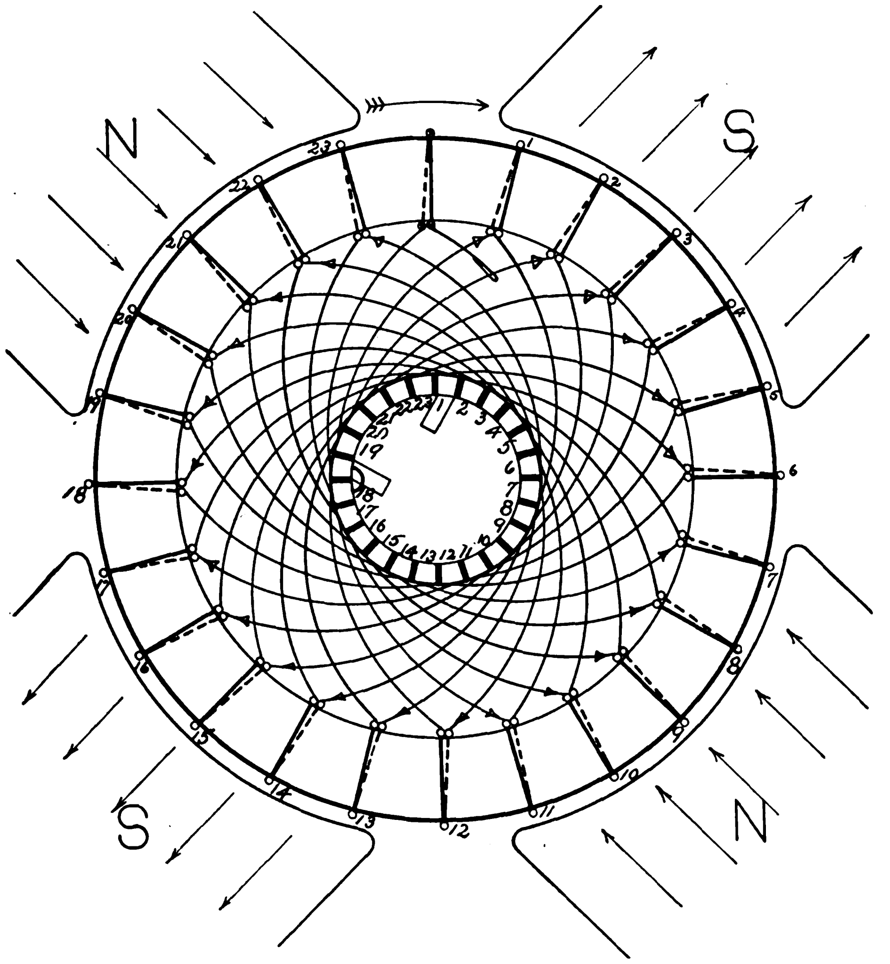


FIG. 5.

The back lead of coil 1 is joined to bar 19, the front lead is connected to coil 12—11 coils ahead—through bar 7; thence to coil 23 through bar 18. This gives two coils between adjacent bars. The front lead from coil 23 would go to the bar numbered 5, if all the bars were to be used and a strictly symmetrical arrangement were to be followed; but the coil which would connect to bar 6 is left dead and the bar next to 18 is short circuited so that the front lead of all coils from 13 to 23 must be set ahead one bar as shown. Practically this reduces to short circuiting the bar to which the back end of the dead coil connects and skipping that bar in making the connection of front leads. The front lead of coil 23 connects, therefore, to bar 6, then to coil 11, to bar 17 and so on.

One brush is found to belong on bar 1, so that the current may come into the armature at that point: Since it is a four-pole machine, the other brush must be at 90 deg., or on the dead bar. The direction of e.m.fs. would place it on bar 18, but bar 18 is connected to the dead bar, so that the current can pass to the brush and thence out to line.

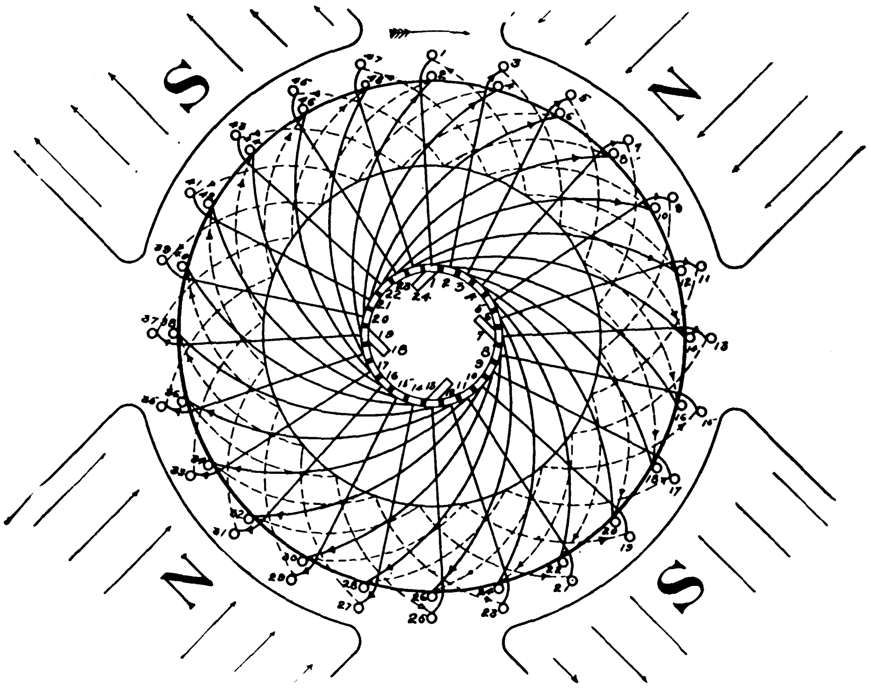


FIG. 6.—TWO-LAYER, FOUR-POLE LAP WINDING.

Between bars 18 and 19 there were found to be two coils; there are six bars between brushes, therefore there will be 6 x 2 = 12 coils in one circuit, and there must needs be 11 in the other, since there are 23 active coils in the winding. By examination, it will be seen that the circuit from bar 18, through coils 23, 10, 21, etc., has 11 coils; the one through coils 12, 1, 13, etc., has 12. Of course, this will produce some slight unbalancing, both of e.m.fs. and of resistances, but it is not found in practice to be of serious importance.

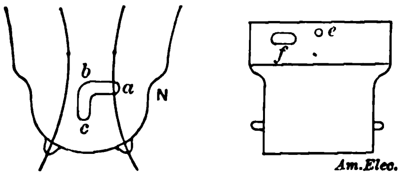
ENGINEERING EDUCATION.

At a recent meeting of the Western Society of Engineers, Mr. J. C. Bley read a paper on engineering education, which led to a discussion showing the usual wide difference of opinion concerning the relative proportion of practical and theoretical instruction. In the course of the discussion Prof. Ricketts, of the Rensselaer Polytechnic Institute, was quoted as regarding manual training of dubious value. His experience was that there were a great many boys who, while they had bright but lazy minds, much preferred to develop their fingers to their minds, and if permitted to go into the manual training schools they applied themselves very diligently to making a little engine or something of that sort, to the detriment of their mental training. For that reason Prof. Ricketts thought that parents and guardians should exercise very great care in sending their children to manual training school. Three of those joining in the discussion of the paper thought workshop training was necessary before or during the intervals of college or theoretical training. Another considered that a scientific man gets more out of an experience than a practical man and will beat him in the long run, and all appeared to agree that an engineer should be a good mathematician and able to use the calculus.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

New Method of Attaching Lamp Bases.—An ingenious method for attaching bases to incandescent lamps without the use of plaster has been used for some time by M. Larnaude of Issy-les-Moulineaux, France, and is described in "L'Industrie Electrique." On the head of the lamp small grooves of the form shown at, a, b, c, in the figure are blown diametrically opposite each other, and arranged to engage with the projections, e, of the brass base. When the base is slipped on and given a turn so that the projection, e, is at the end, a, of the groove, the oval hole, f, in the brass is brought opposite the vertical part, b, c, of the groove. A drop of special solder put into the hole, f, is sufficient to secure the base tightly to the lamp. The disadvantages of plaster are specially noticeable in damp situations, and it is said that lamps provided with these all-metallic bases are better able to withstand moisture.



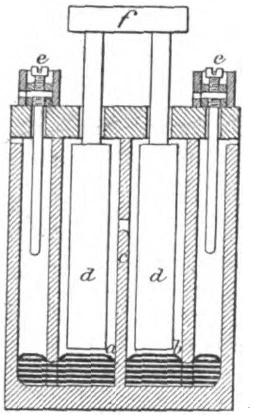
A LAMP BASE WITHOUT PLASTER.

A New Material for Fluorescent Screens.—According to "L'Industrie Electrique," MM. Ducretet and Roger have discovered that the white celluloid used for making collars and cuffs, fluoresces brightly when exposed to X-rays. This material is loaded with zinc-white, to which, doubtless, its fluorescent properties are due.

A Substitute for Platinum in Incandescent Lamps.—The "Electrician" states that experiments lately made in German show that iron-nickel alloys of various proportions have widely different coefficients of expansion, and that such an alloy containing 45 per cent. of nickel possesses the expansion rate of platinum. It is stated that experiments made at the Reichsanstalt confirm this and it has been proposed to use the alloy to replace the platinum leading-in wires of incandescent lamps.

Electricity at the Paris Exposition.—Electricity will play a large part at the Paris Exposition of 1900, says the "Revue Technique." No less than 15,000-h.p. will be used for lighting and 5,000-h.p. for furnishing electric power to the various parts of the grounds. As far as possible all the machinery exhibited will be shown at work and for this purpose electric conductors will be laid down to all points on the grounds. The boiler plant will be located at the end of the Champ de Mars, and will occupy two spaces of 130 x 390 ft. each, one being devoted to French boilers and the other to those of foreign makers. This plant will be, in itself, a very interesting exhibit. It is proposed to provide a capacity for evaporating not less than 440,000 lbs. of water per hour.

A New High-Tension Switch.—At a recent meeting of the Societe Internationale des Electriciens some new forms of switches for handling high-tension currents, invented by M. Bouchet, were described. The illustration clearly shows the principle upon which they work. An insulating case contains two cavities filled to the same level with mercury and separated by an insulating partition, c, in which is a hole normally above the level of the mercury on the two sides. Plungers, d, d, are manipulated by the cross-head, f, so that when they are forced down into the mercury its level rises, contact being made with the two electrodes attached to the terminals, e, e, and through the hole in the insulating partition. When the plungers are withdrawn the level falls and contact is broken at the hole and also at the tips of the electrodes attached to the binding posts, e, e. It is stated that no arc is formed, the surface tension of the mercury preventing it. The apparatus being entirely inclosed there is no oxidation. An interrupter of this type has been successfully used at Paris for a current of 12 amps. at 3,000 volts.

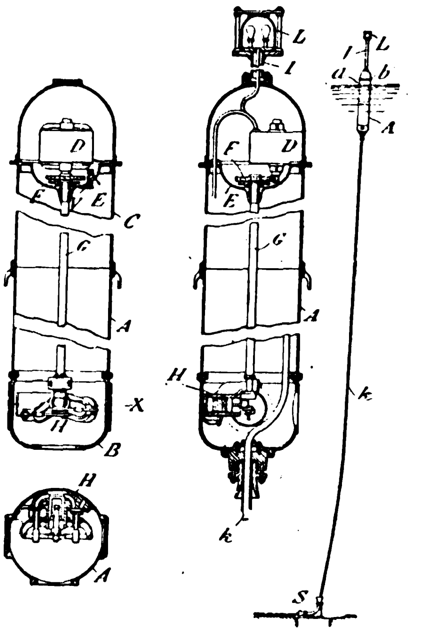


A NEW HIGH-TENSION SWITCH.

Engine Room and Shop Floors.—On account of the vibrations due to engines and other machinery the ordinary cement concrete floor has not been found entirely durable. An advantageous composition, according to "Erfindungen und Erfahrungen," is made of lime, sand, cement and clinkers, which should be used in thicknesses of at least 10 ins. The best mixture is said to be: Portland cement, 1 part; unslaked lime, ½ part; sand, 3 parts, and sifted clinkers, free from ashes, from 7 to 8 parts. For a top dressing of finer mass the composition should be 1 part cement, 3 parts sand and 2 parts of finely ground and sifted clinkers, the dressing to be well rammed and rolled after laying. Floors constructed in this way are said to be practically indestructible.

A New Incandescent Lamp.—Professor Nernst of Gottingen University has invented an incandescent lamp having an efficiency of 1.1 watts per candle. Up to the present, says the "Electrician," no particulars of the construction of the lamp have been published, but short articles in the German technical papers have described the principles of the invention. When magnesium oxide is heated to redness it becomes an electrolyte. A hollow rod of this material is used as the incandescent body of the lamp. It has first to be heated to incandescence by an outside source and then supplied with current to keep up its temperature and offset the losses due to radiation, conduction and convection. An alternating current must be used to avoid decomposing the magnesia rod. A cylindrical rod ¼-in. long and 1-6-in. diameter, glowing in air, is stated to have given 26-c.p. with 27 watts.

Disappearing Electric Buoys.—In a most interesting series of descriptions of applications of electricity in navigation and on shipboard, "L'Eclairage Electrique" includes an account of an ingenious channel buoy, devised by Siemens, which can be made to sink at will. This property would be useful in cases of a threatened invasion by an enemy, as a harbor could be cleared of these finger posts of navigation in a few minutes. The buoy consists of the usual metallic case attached by cables to an anchor and carying incandescent lamps on its upper part for lighting the channel at night. A small polyphase induction motor in the buoy is coupled to a centrifugal pump, which fills or empties the buoy according to the direction of its motion. This pump has a very large clearance, so that if it is operated after the buoy is discharged



AN ELECTRIC DIVING BUOY.

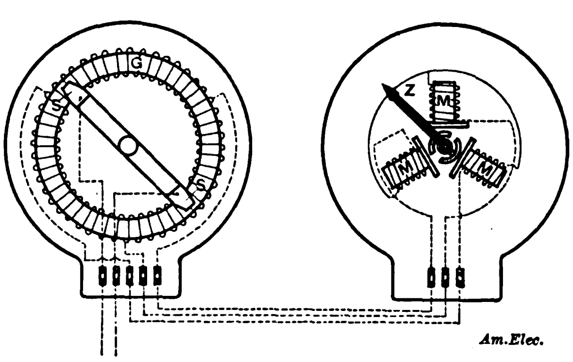
of water it will not create a partial vacuum in the case and cause the water to again enter and sink the buoy when the motor stops. The motor is in a chamber partitoned off from the rest of the case, so that it is not liable to be wetted by the submergence of the machine. By using a three-wire three-phase circuit two of the wires can be used at all times to carry current for lighting the lamps.

A 100-Mile Transmission Project.—A plan has been devised in Stockholm, according to the "Frankfurter Zeitung," for the utilization of part of the power of the waterfall of Elfkarleby, situated 100 miles from that city, where about 100,000 h.p. is continuously wasted. The idea of transmitting part of this power to Stockholm has, it is said, taken definite shape, and several engineers have been retained to work out the scheme. Their report is now ready. It is proposed to begin by utilizing 20,000 h.p., the estimated cost of the installation being given as follows: Power station, including all the machinery and works, $890,000; transmission line, $1,165,000; buildings and transformers in Stockholm, $145,000; the total being $2,200,000. It is estimated that the full load loss will be 25 per cent., and that 15,000 h.p. will be available for rental in the city, the price being fixed at a little over $11 per year per horse-power.

Electrochemical Equivalent of Carbon.—"L'Electrician" gives in brief the results of M. A. Coehn's researches upon the electrochemical equivalent of carbon. When carbon is used as the anode in the electrolysis of a liquid liberating oxygen, it disintegrates. This phenomenon is due partly to chemical action and partly to mechanical causes. At the first glance the action seems to depend upon the electrolyte used. Thus, if the action produced upon carbon anodes by electrolysing, in connection with platinum cathodes, under a current of about 0.12 amp., solutions of sulphuric acid in 1, 10, 20, 50, 100 and 500 parts of water, is studied, at the end of about ten hours it is noticed that the most concentrated solution is clear while the weakest is strongly colored, intermediate solutions showing intermediate degrees of darkening. By accounting for the particles of carbon mechanically detached and substracting their weight from the total loss of the electrode, 2.7 to 3.0 is obtained as the electrochemical equivalent of carbon, and this figure is independent of the concentration or temperature of the electrolyte.

Electric Conductors and Powder Magazines.—A committee of the Academie des Sciences was formed at the instance of the French Minister of War to investigate the question of fixing electrical conductors in or near powder magazines, and their report has been presented. They make no distinction between telephone and telegraph wires, and electric light and power conductors, since all these may be exposed to lightning. According to "Industries and Iron" the report may be summarized as follows: All underground electric conductors as well as gas and water pipes must be kept at least 30 feet away from the magazine. Aerial lines must be arranged so that they will not fall upon the magazine if broken, and it is recommended that none be allowed within 60 feet of the magazine. If light be required inside the magazine all wires are to be in strong metallic pipes and all switches, fuses, etc., are to be placed on the exterior of the building. Only fixed lamps are permissible, and these must be protected by a second envelope of glass. No voltages over 110 are to be used. Any electric bells required must be placed at least 12 ft. from the powder and only types using very small currents are permitted.

Signaling with the Rotating Field.—An interesting variety of signaling, due to Dr. L. Weber, is described and illustrated in "L'Elettricita." The principle of the apparatus may be readily understood from the accompanying illustration. The signal system is intended to replace the step-by-step systems now used for many purposes, but especially for signaling from the bridge or pilot-house of a vessel to the engine room. In apparatus of this character similar dials are used at the extremities of the line, the signal being given by moving an index lever over the dial at the sending end and this causing a corresponding movement of an index hand over the receiving dial. Dr. Weber's apparatus uses a rotating magnetic field. The sending instrument is shown on the left in the illustration. A direct current is led to the extremities, S, S, of the index lever which rest upon opposite points of a commutator connected to the resistance coil, G. This is tapped at three equidistant points, these being connected to three equal and equally spaced magnets in the receiving apparatus, as shown in the illustration. A small two-pole armature of soft iron carrying an index needle completes the apparatus. When the signalling lever, S, S, is moved the distribution of magnetism in the three coils, M, M, M, moves correspondingly, carrying with it the index needle, Z. For use on shipboard the apparatus is made reversible by combining the sending and receiving mechanism at each end so that the engineman can signal back to the bridge his receipt and understanding of the signal. The apparatus has some points of superiority over the step-by-step system, being less complex and less liable to derangement by the movement of the ship or, in the case of naval vessels, by the shocks of battle.



ROTATING FIELD SHIP SIGNAL.

Gas Engines for Poor Gases.—In a contribution to the "Memoires de l'Union des Ingenieurs de Louvain," M. E. Heirman discusses the working of gas engines with poor gases and describes a new cycle which possesses many points of advantage. The mixed gas and air is introduced under pressure behind the piston at the beginning of the stroke, cut off by a valve at any desired point, and simultaneously ignited. Expansion thus takes place up to the end of the outward stroke. During the return stroke the products of combustion are entirely expelled, as there is no clearance space or compression chamber in the cylinder. In this way two important objects are attained, an explosion for every revolution and an automatic cut off like that of a steam engine. The mixture of gas and air is maintained at constant proportions for the best efficiency and its initial compression (effected outside the working cylinder) can be carried to any desired point. Accurate regulation is secured and the size and weight of the engine for a given output considerably reduced. M. Heirman thinks that the possibility of using furnace gases and other poor gases in engines of this type opens a very broad field for the extension of the gas engine.

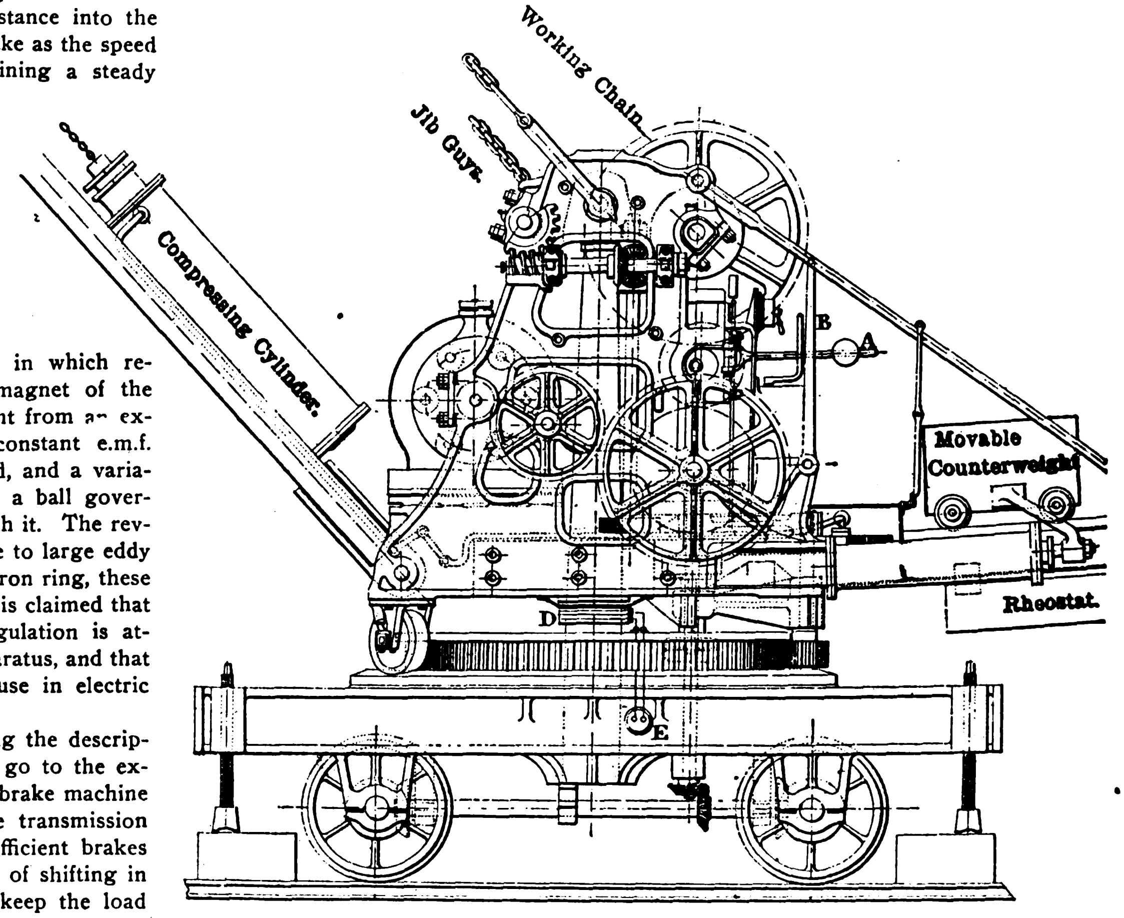
The Electric Arc as a Telephone.—Some exceedingly curious experiments are described in a paper by Herman Simon in "Wiedmann's Annalen" which go to show that the arc can act as a telephone receiver or transmitter. The primary of a small step-up transformer was connected in circuit with the arc, which was, of course, maintained by a steady direct current. The circuit with the secondary of the transformer was connected a microphone and its battery. Whistling, singing and even speech were distinctly transmitted and reproduced at the arc, a common glass funnel held near the arc and supplied with a rubber ear tube acting as the collector. When the arc is lengthened the sounds emitted become louder and more distinct, this being due to the increase in the resistance of the arc and the amount of energy expended in it by the current. The explanation of the curious action is, of course, the heating of the arc vapors by the alternating microphone current, thus altering the volume of the arc space and setting up corresponding sound waves in the air. The apparatus is reversible, as the effect of sounds upon the arc are to cause an alternate increase and diminution of its volume, and hence its resistance, and so modify the supplying current.

The "London Electrical Review," in commenting upon this experiment, says: "We do not recommend this invention for commercial use; the language transmitted through the present telephone is usually heated enough; at least there is no necessity for passing it through an electric furnace."

Electric Brakes as Turbine Governors.—A novel system of regulation for water wheels, due to M. E. H. Rieter, is described at great length in "L'Electricien." It consists of an electric brake of peculiar construction, driven by the water wheel, and controlled by a ball governor which switches more or less resistance into the energizing circuit of the brake as the speed falls or rises, thus maintaining a steady load upon the wheel. Of this form of regulation is only useful where there is no desire to economize the water, as the wheel works continually at full open gate. The brake consists of a cast iron ring, having a corrugated outer surface to better its heat radiating qualities, in which revolves a multipolar field magnet of the Brown-Boveri type. Current from an exciter or other source of constant e.m.f. is used to energize this field, and a variable resistance controlled by a ball governor is included in circuit with it. The revolution of the field gives rise to large eddy currents in the mass of the iron ring, these being dissipated as heat. It is claimed that very close and accurate regulation is attained by the use of this apparatus, and that it is specially adapted for use in electric power transmission plants.

One wonders, after reading the description, why it is necessary to go to the expense of building a separate brake machine when the dynamos of the transmission plant are themselves most efficient brakes of the same class. The idea of shifting in and out dead resistance to keep the load steady on a water wheel driven generating plant and thus to maintain a steady speed, is by no means new, and such arrangements are in use in several parts of the United States. It is unnecessary to have a ball governor, even, as an electromagnetic device in the working circuit will manipulate the resistance as required and will even compound the plant, so to speak, by allowing a somewhat higher speed at heavy working loads. Just why it should be considered necessary to go through the complicated cycle of energy transformation used in this form of governor when the water wheel is driving a dynamo, is hard to see, but the machine would probably prove of excellent use in the regulation of wheels driving other than electrical machinery.

An Electric Crane.—M. Emile Evers contributes to the Memoires of the Societe des Ingenieurs Civils de France an account of an electric crane possessing some novel and ingenious features. The crane is of the type used about docks, consisting of a platform running on rails and surmounted by a rotating part carrying the motor, with a jib and its guys on one side and a counterweight on the other. The principal novelty in M. Evers' design is the automatic adjustment of the counterweight to balance whatever load is suspended from the jib in the various positions the latter may take. The main working chain of the crane goes over a pulley at the end of the jib, through a block to which the load is attached, back through another pulley on the jib, and is anchored to the piston of a cylinder containing some fluid such as oil. This cylinder communicates by appropriate pipes and valves with one or more cylinders on the other side of the main pivot of the machine, to these being attached the movable counterweights. As the pressure on the first cylinder increases it is transmitted to the counter-weight cylinders and forces the counter-weight further away from the pivot for heavier loads on the crane. The track upon which the counter-weight runs is inclined upward in a curve, so that the position of equilibrium is determined by the weight on the end of the jib. When the load is released the counter-weight descends by gravity to its initial position, also pulling in the end of the main chain and leaving the whole machine ready for another load. The operation of this crane is said to be very successful.



AN ELECTRIC CRANE.

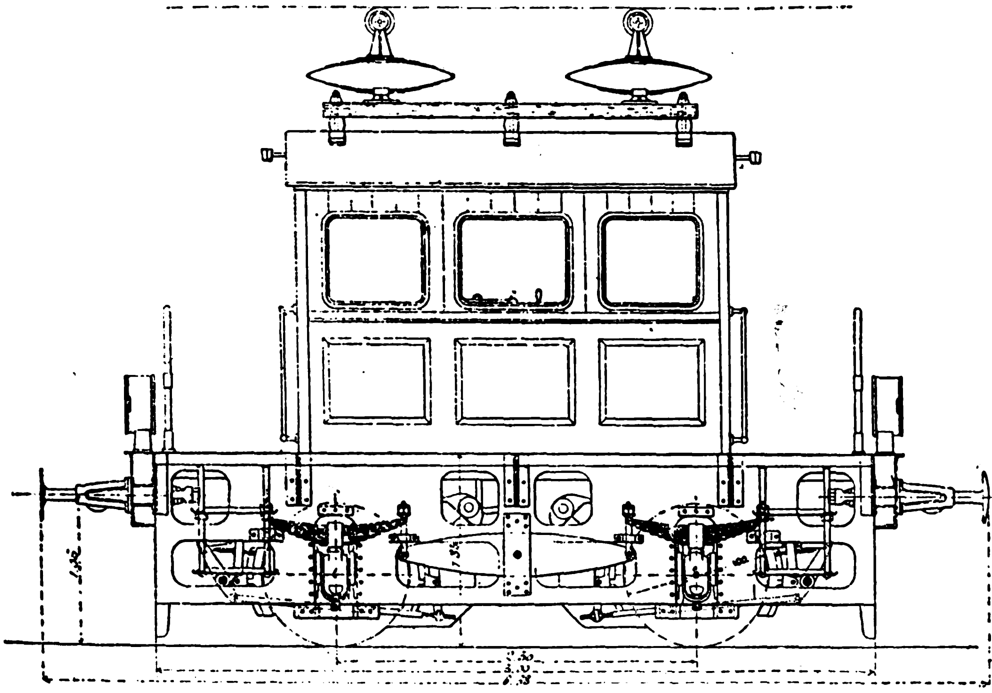
Phosphorus by the Electric Furnace.—"L'Industrie Electro-Chimique" notices three recent processes for the manufacture of phosphorus in which electricity plays a part. The Gin and Leleux process consists of heating, in an appropriate electric furnace, a mixture of phosphate of lime and coke. The two ingredients should be finely powdered and the mixture should be homogeneous. When, under the action of the heat, the mass becomes pasty, all the openings of the furnace are hermetically sealed except that for the passage of the phosphorus vapor, which is distilled out and collected in the usual way.

In the Boublique process iron phosphide is decomposed by electrolysis, this salt being produced by fusion of phosphate of lime with a salt of iron. The disengaged phosphorus vapors are carried away by a current of some inert gas.

The Collardeau process consists of the preparation in the electric furnace of a mixture of calcium carbide and phosphide. By using a mixture of 310 parts of phosphate of lime, 260 parts of quick-lime and 160 parts of coke nearly all the phosphorus goes into combination as calcium phosphide. The phosphuretted hydrogen obtained from this product is led through a tube filled with fragments of coke and maintained at a red heat, the gas breaking up into hydrogen and phosphorus.

The Hulin Alkali Process.—An interesting dry electrolytic process for the manufacture of caustic soda and bleaching powder from salt is described in the "Electrician" by Mr. John B. C. Kershaw. The process is due to M. Leon Hulin, and is a modification of the Vautin process which was unsuccessfully tried in England some years ago. In the latter process a cathode of molten lead was used, it being expected that the liberated sodium would alloy itself with the lead and thus be removed from the electrolyte, which consisted of fused salt. The difficulty encountered was the formation of a crust of the lead-sodium alloy on the surface of the cathode which was impervious to the passage of the sodium ions, and these were forced to escape at the surface of the bath where they burned. The compound of the fused salt, lead and free sodium also attacked the materials of the crucibles and the process was on these accounts unsatisfactory. M. Hulin's method is both simple and effectual. A certain percentage of lead chloride is maintained in the crucible by the diversion of a part of the electrolyzing current through a lead anode, and the electrolysis of this produces ions of lead at the cathode simultaneously with those of sodium. The two immediately alloy and are regularly and easily dissolved in the molten cathode. By the action of water upon the metal of the cathode after the electrolysis of the charge a solution of very pure caustic and spongy lead is obtained, hydrogen being liberated; or the alloy may be heated in a current of air, oxidizing both the lead and the sodium, and the caustic recovered by lixiviation, lead peroxide remaining. Both the spongy lead and the peroxide are valuable by-products, and doubtless some use can be found for the nascent hydrogen liberated. The current density in the cells may go to nearly 1,000 amps. per square foot, but the best results are obtained with a density of 700 amps. This process requires more energy than others for the production of the same quantity of caustic and chlorine, but the by-products are very valuable. A plant is now being erected at Clavaux, Isere (France), where a water power of 5,000 h.p. will be used, the turbines being direct coupled to 375-k.w. direct current dynamos.

A German Electric Locomotive.—A new type of electric locomotive has been constructed for service on the Prussian railways, and it is fully described in the "Annalen fur Gewerbe und Bauwesen." The locomotive, as may be seen from the accompanying illustration, is symmetrical in design and adapted to run either way equally well. It weighs 20 tons and can haul a 120-ton train at a speed of 31 miles per hour on a level track. Two motors are carried, one geared by a 3 : 1 gearing to each axle. The truck is a rectangle of stout steel plate, the buffers and draw-head being attached directly to it. The weight of the superstructure is borne by four leaf springs, as the illustration shows. The cab is of wood, with windows in all sides. Control is effected by the usual series-parallel arrangement, a resistance being used at starting. The trolleys are two bronze rollers supported by carriage springs, and a double trolley wire is used in order to increase the area of contact, both wires being of the same polarity. At 500 volts the locomotive has a speed of 30 miles per hour and a current consumption of 125 amperes, giving 84 h.p.

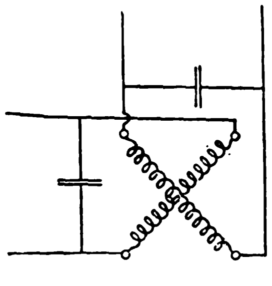

SIDE ELEVATION OF A GERMAN ELECTRIC LOCOMOTIVE.

An Electric Idyl.—They do things gracefully in some parts of Europe. Here is a literal translation of the report of the inauguration of a new electric lighting system in the little Swiss town of Grand-Saconneux, appearing in the "Journal de Geneve":

"The village inaugurated its new system of electric lighting last Tuesday evening by a charming little improvised festival. The town Council was assembled to take possession of the new installation and to see its perfection. Around them, on the Town Hall square, the village brass band and nearly the whole population assembled. After two pieces of music and a few words by the mayor praising the excellent workmanship of the installation and thanking those who had contributed to so handsomely light the village, the officials and sub-officials of the electrical department, the procession set itself in motion, the band in front, to get acquainted with the different street lamps. At each end of them a well garnished table immediately appeared and a representative of that part of the village expressed in a few simple words the satisfaction of the public. This joyful journey accomplished, not having neglected the mayor's house by the way, the crowd, still compact, returned to the Town Hall square. This must now be rededicated, so, to the gay strains of the faithful band, the young people organized a charming bal champetre and took possession of their new territory by joyfully frolicking there."

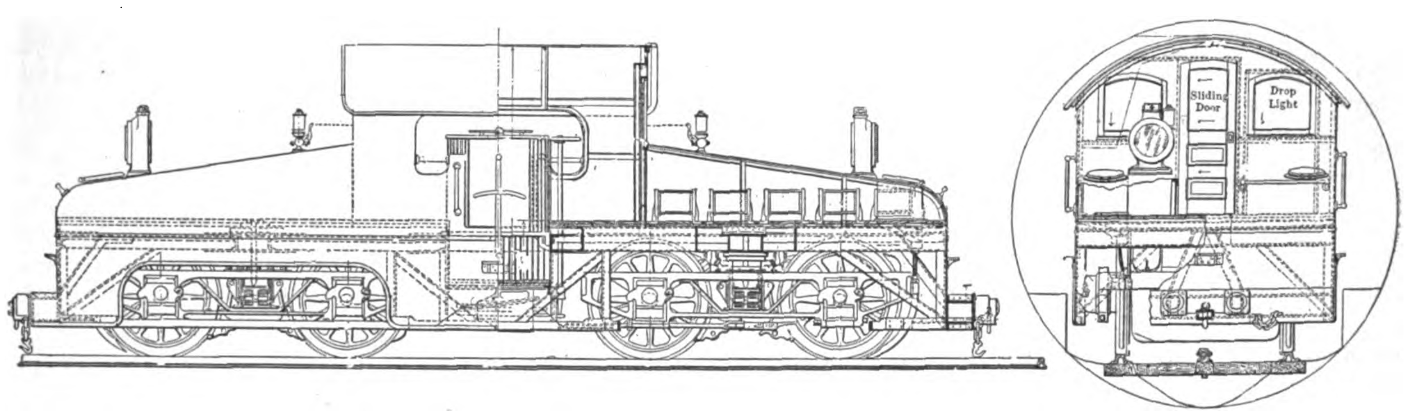
All very proper and lovely. "L'Energie Electrique," commenting on this idyllic tale, says that "there were 200 street lamps, from which circumstance the gayety of the crowd after refreshing itself at the 199th can be imagined."

Commercial Condensers.—Some interesting facts regarding condensers are contained in a paper lately presented to the Societe Internationale des Electriciens by M. Boucherot. His experiments were confined to condensers constructed with paraffined paper as the dielectric, his experience having led him to think this the best material for the purpose. A great deal depends upon the quality of the paper, by which is meant its capacity to resist puncture and cracking at high electrostatic stress. Resistance to puncture, according to M. Boucherot, seems to depend on the mechanical strength of the paper rather than upon its specific insulating quality. As all dielectrics are more or less conducting there is always a certain amount of loss in a condenser which makes itself manifest as heat, the temperature attained depending on the radiating power of the case of the apparatus and the C^2R losses in it. These latter increase with the square of the voltage, so that a condenser that is very satisfactory at a given potential difference may heat and be destroyed at a higher voltage. If the "power" of a condenser is taken to be the product of the effective voltage at its terminals by the apparent current flowing into it the prices of condensers vary with the frequency at which they are used and the tension. For a frequency of 40 cycles per second condensers for 600 volts cost $30 per kilowatt, and for 3,000 volts $20 per kilowatt. For 120 cycles per second they cost, for the low and high voltages respectively, $10 and $6.50 per kilowatt. Apparently the most fatal defect of condensers of this type is the enormous decrease of the insulation resistance of paraffine with increasing temperature. Paraffined paper which shows a resistance of more than 10 megohms per square centi-


CONDENSERS IN ALTERNATOR EXCITING CIRCUIT.

meter (at 19 Centrigrade) falls to about ½ megohm at 99.

An interesting application of condensers shown by M. Boucherot is that of furnishing exciting current for alternators. The condenser excited machine he exhibited consisted of two similar parts, both armatures, so to speak, alike as to number of poles and winding, one of which was fixed while the other revolved. If this machine be connected to condensers, as shown in sketch, and turned it will furnish alternating currents in the two circuits of its armatures. The explanation of its action is that the condensers furnish a current leading in phase a quarter-period ahead of the e.m.f., while, in an alternator, e.m.f.s. are produced lagging in phase a quarter-period behind the magnetic flux. Hence the condenser current is in phase with the magnetic flux and can produce it. In the machine described a rotating field of half the angular velocity of the moving armature is maintained between the two by the condensers. It is not impossible that this very interesting type of machine may find practical uses, since it has no collector rings or brushes; but it unfortunately needs to be "started" every time it is desired to use it, as it holds no residual magnetism.



ELECTRIC LOCOMOTIVE FOR CENTRAL LONDON UNDERGROUND RAILWAY.

The Central London Railway.—The new underground railway, now under construction in London, is to be operated by electricity throughout and will present one of the most complete and well worked out systems of electric traction extant when it is finished. An interesting description of its engineering features appears in the "Railway World," from which the accompanying illustrations are taken. The road is underground throughout, at a deep level in order to be well out of the way of sewers, etc., and extends from Shepherd's Bush to the Bank, a distance of 10,163 yds.. Including the terminal tracks electric traction is provided for over 6.47 miles of double track. Thirty-two electric locomotives are under construction, each capable of hauling seven double truck saloon carriages, the train exclusive of the locomotive weighing (loaded) 105 tons and seating 336 passengers. The average speed called for by the schedule is 14 miles per hour, including 20-second stops at each of the thirteen stations. The tracks at each station are level, but fall away at a considerable grade on each side so that the trains are aided in starting and stopping by the grades. The generating station is at the extreme western end of the line. Steam is supplied by sixteen water-tube boilers automatically stoked, a coal storage tank of a capacity of 1500 tons being provided. Each pair of boilers is piped direct to one engine, a main header being also provided so that the boilers may be connected together in the usual way. The six engines of the first installation are of the cross-compound Corliss type, each of 1000 i.h.p. They are direct coupled to three-phase generators of 850 k.w. each, giving a voltage of 5000 direct from their stationary armatures. The main circuit high tension switches are so arranged as to break circuit simultaneously on both sides of the board, thus obviating any danger of arcing across their terminals. There are now being installed three sub-stations, but a fourth will be needed when the two-minute headway eventually contemplated is introduced. At each of these sub-stations, there will be three stationary transformers of 300 k.w. each and a rotary converter of 900 k.w., supplying direct current at 500 volts to the track conducting system. These sub-stations are located at the bottom of the elevator shafts at three stations. The stationary transformers are of the air blast type, the warm air being blown up through sheet iron pipes in the center of the spiral staircase that gives access to the stations. A third rail of channel section, weighing 80 lbs. per yard, is used as the working conductor. This is bonded with two bonds aggregating 420,000 c.m. at each joint, but it is not provided with fish plates. The track rails are of 100-lb. section and are bonded with both crown and plastic bonds.

As the tunnels are only 11 ft. 6 ins. in diameter inside, the construction of the locomotives presented no little difficulty. Each has two trucks, each of the two axles of each truck being provided with a motor, mounted direct without gearing. The total power of each locomotive is 260 h.p., at a speed of 27 miles per hour. The tractive effort at 22 miles per hour is 8000 lbs.

It is very interesting to note that the greater part of this fine installation is American. The boilers, coal conveyors, steam piping and valves, engines, dynamos, rotary converters, locomotives, rail-bonds, elevators at the stations, air-brakes and other minor features are all American. The contract price for the complete work, including the tunnels, was $16,200,000.

British Machine Shop Methods.—A new dynamo and motor works has been recently opened near Glasgow, with an elaborate plant of machinery, and is described at length in several of our English contemporaries. The praise bestowed upon certain new methods inaugurated in this well planned works throws a strong light upon average British machine shop practice, and seems curious to an American reader. For example, a marked innovation is the installation of a tool room where tool-makers are kept constantly busy in making and keeping in order standard tools, so that the machinists are not compelled either to stop their machines to make or grind their own tools or to wait for this to be done for them. This departure is spoken of as a novelty, and this fact illustrates strongly how conservative the older regimen of such shops has been. The differentiation of labor that has been carried to so great a length in this country and that has been productive of such excellent results, has apparently been opposed on the other side by the conservatism that is a marked feature of English character, and it is only now that the valuable object lesson taught by the accurate and cheap output of American shops is beginning to impress itself there. Attention is called in these articles to the fact that the main shop is heated in winter by the exhaust from the engines used, and this provision for the comfort of the men is thought praiseworthy. A curious difference in methods from those obtaining here is illustrated by the fact that the slots in all the armatures made by the new works are milled from a core built up of plain circular discs. It is claimed that this method gives better spacing and alignment of the slots than the usual practice of stamping out the teeth of the disc. It certainly seems to be a laborious and expensive process. In the light machines for brass working, etc., to quote one of the descriptions: "Advantage has been taken of the most modern improvements in American design and the result is an immense improvement in the economy and accuracy of the product."

Throughout the works the electric transmission is used, there being no line-shafting anywhere. As in many similar foreign installations a concentric cable is used for the transmission circuits, the inner core being positive and the outer cylindrical part being left bare and grounded.

New Types of Polyphase Motors.—Two very interesting types of polyphase motors were described by M. Boucherot before the Societe Internationale des Electriciens at a recent meeting. In the ordinary types of induction motors using a short-circuited rotor the difficulty of starting them, especially under load, without enormous rushes of current, rapidly increases with the size of the motor. The well known method used to avoid this difficulty—connecting a variable resistance in circuit with the rotor winding—necessitates the use of collector rings, and also requires that the winding be of a sufficiently great number of turns to give a reasonable voltage at the collector rings. The simplicity and mechanical excellence of the "squirrel-cage" cannot be made available when the size of the motor necessitates this opening of the rotor circuit for the introduction of resistance. To start an induction motor on a load and to operate it efficiently at speed require different windings. Except in the case of motors working centrifugal pumps, fans, etc., where the load at starting is practically nothing, the interposition of a resistance in the rotor winding is almost invariably necessary. It has been for a long time a great desideratum to rid the motor of this cumbersome and costly auxiliary and to make it self-contained. M. Boucherot's solution of the problem is extremely simple and elegant. He combines on the rotor two windings; the first such that, if it acted alone, the curve of torque and speed would be similar to that of I, Fig. 1, and the other such that its corresponding curve, when acting alone, is like II, Fig. 1. With the first winding there is a large starting torque which rapidly falls off as the motor approaches synchronism, so that the slip at full load would be excessive and the efficiency and output correspondingly low. The second winding possesses an extremely feeble starting torque, but this increases with the speed, and at full speed is sufficient to keep the slip low and the efficiency of the two give rise to a torque and speed curve like III, Fig. 1, showing a high starting effort and a satisfactory running torque at full load and speed. Of course these windings may be of any of the usual forms, but the squirrel-cage is preferred for mechanical reasons. The first winding should have as high a resistance and as low a self-induction as possible, while the second should be of low resistance and very great self-induction. Instead of the simple case of two windings here described, there may be combined any number of separate windings differing in their time-constants in the proper manner, but it is found in practice that two, or at most three, such windings are sufficient for all ordinary purposes. Fig. 2 shows an end elevation and axial cross section of such a rotor. A first series of holes, $T_1T_1T_1$, is provided near the periphery of the rotor as in the ordinary squirrel-cage construction. Through the body of the rotor another series of holes, $T_2T_2T_2$, is also provided, the numbers of holes in the two sets being the same. Narrow, slits, FF, connect the two so as to augment the magnetic resistance of the annular spaces comprised between the two series of holes and to diminish the dispersion of lines of force and compel them to pass through the second circle of holes. In the outer tunnels are copper bars connected at their extremities to the rings, C_1C_1, or iron, ferro-nickel, German silver or other high resistance metal. The copper bars in the inner series of holes are connected to the two rings, C_2C_2, of copper. At starting when the inducing magnetic flux traverses the rotor at high frequency (that of the supply circuit), even a small portion of it penetrating the interior of the inner winding suffices to set up large currents in it, tending to oppose the passage of the flux in this part and restrict it to the annular space between the two sets of windings. Thus the high resistance outer squirrel-cage works practically alone in starting the rotor, giving a high initial torque. As the speed increases the frequency of the flux relative to the windings diminishes, more and more of the flux passing through the inner winding and bringing that into play, until, at full speed (nearly synchronism), the rotor is running on the low resistance winding like an ordinary induction motor.

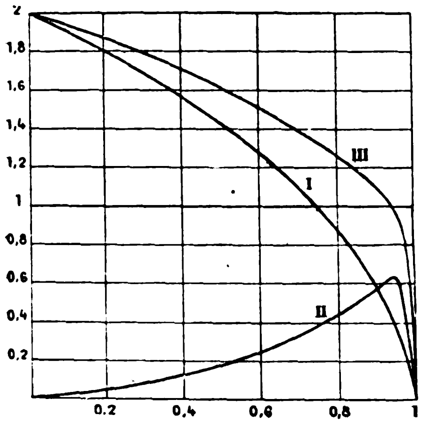


FIG. 1.—CURVES OF TORQUE AND SPEED.

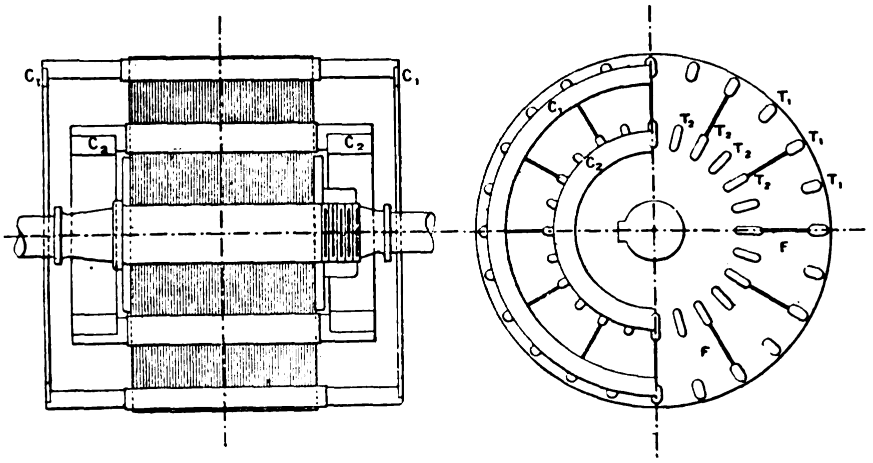


FIG. 2.—ROTOR OF SELF-CONTAINED INDUCTION MOTOR.

M. Boucherot meets the greatest objection to this type, that of the increase of wattless currents due to the second winding and the consequent lowering of the power factor of the machine, by saying that in most cases this makes no difference. The type of motor described is said to be particularly well adapted to operation from a distance, since it is entirely self-contained.

Another type which accomplishes practically the same results in a different way consists of the combination of two identical fields or stators, one of which is fixed in place on the frame of the machine, while the other is free to rotate between the positions of coincidence and opposition with it. The armature or turning part consists of two similar rotors, with slots near the surface, mounted on the same shaft, the copper bars of the squirrel-cage running through both. At the outer ends these are connected in the usual way by heavy copper rings, and in the middle they are connected by an iron or other heavy resistance ring. At starting the two fields are placed in a position of opposition so that the currents developed in the two halves of the bars of the rotor are opposed. These currents combine in parallel through the high resistance ring, giving the needed starting torque. As the speed increases the movable field is turned into the position of coincidence with the other and the motor then becomes an ordinary induction motor. The turning of the movable field is accomplished either by an endless screw or other appropriate mechanism, and the switch is combined with it so that the starting current cannot enter the stator except when it is in the proper position.

These solutions of the problem of starting induction motors are so ingenious and simple that it seems thankless to criticise them, but the decreased power factor seems to be a considerable objection. It is the low power factor of induction motors more than anything else that has limited their usefulness.

REGULATION IN CENTRAL STATIONS.

BY WM. H. CHAPMAN.

"An ounce of prevention is worth a pound of cure." This is a good maxim to set out with in any line of work, but a point is soon reached along any path of progress where the stubborn fact appears that after all possible efforts have been put forth in the way of prevention, many evils still crop out for treatment in the way of cure.

In no line of business does this appear more emphatically than in central station work, where electric currents are generated and supplied for various commercial purposes, requiring in some cases constant potential with varying current, and in other cases constant current with varying potential. To generate currents of just the kind needed and so prevent variation at the outset is one thing; and to correct variations as they occur is another thing. In practice we are compelled to work along both of these lines, and while the first is the most desirable to attain, yet we are compelled to resort to the second.

The all important factor in the preventive problem is constancy of speed at the generator, even under widely varying conditions of load. Accordingly, the most persistent efforts of steam engine designers have been for years devoted to this task of fine speed regulation, with results that are even better than could have been expected. The same is also true of water wheel governors, and we have in this line machines of marvelous ingenuity combining sensitiveness with power. And yet, as if to mock the efforts of these persistent workers who have really accomplished so much, electrical generators have the unhappy characteristic of exaggerating the faults of others, and while the variation of speed may not exceed two per cent., the resulting variation of voltage may be as high as four per cent.

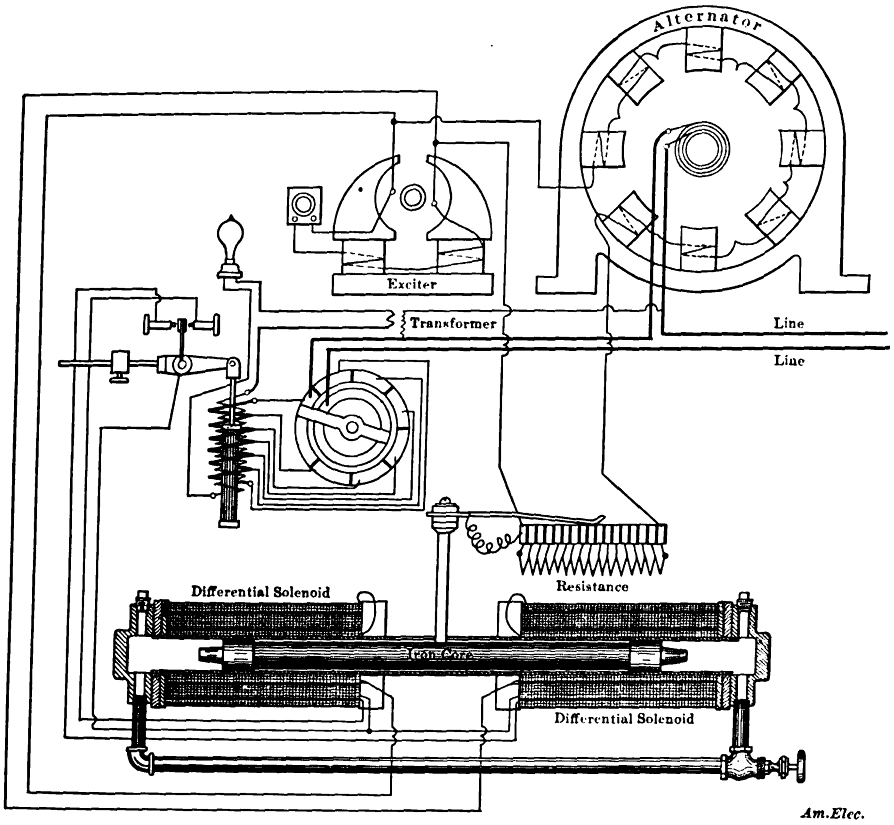
The variation of voltage in a generator due to changes of speed is not simply proportional to the speed, but is much more than that, and in some cases is more nearly as the square of the speed. To avoid the evil results of this law of rapid increase, generators sometimes have their field magnets excited by a dynamo driven from a separate and independent source of power. This, however, is not always convenient or even possible, as is shown by the usual practice of self excitation or excitation from a dynamo driven from the same line of shafting as the generator.

Variations of voltage due to armature reaction may be well taken care of by proper compound windings on the field magnets, yet the success of this presupposes a constant speed, and after all has been done that can possibly be done to prevent variation, there still remain a great many causes that can only be dealt with when their results begin to appear.

The one universal primitive way of meeting the necessity is a rheostat, a voltmeter, and a man to serve as a connecting link between the two. In most cases the man acts as a mere machine, and his duties could be performed better and with more uniformity by the substitution of a very simple form of regulator having a pair of platinum contacts in place of eyes, and magnetic force in place of muscular force. However, his duties are not always so simple, since he may have to take note of a multitude of feeders and mains, distributing centers and potential wires, and armeters as well as voltmeters, but in every case his final controlling action is performed at the rheostat, and by strict attention to business he may at the rheostat accomplish the regulation of the system in a very satisfactory manner. The action of the man from day to day and hour to hour, is, however, performed with a systematic regularity that convinces us that the most complicated systems of electrical generation and distribution may with great advantage be placed under automatic control, subject to the determination of the operator only as to what kind of regulation is applied to certain circuits at certain portions of the day.

The first requisite of a system of automatic regulation is a sensitive device to detect slight variations of voltage or of current, or of both at the same time, according as the basis of regulation is respectively constant potential at the station, or constant current, or constant potential at some given distant center of distribution. The device also must not only detect the variation, but must also be able, without interfering with its sensitiveness, to direct a power sufficiently great to operate a rheostat for the correction of the variation.

In such a device either one of two principles may be adopted—the expansive force of a hot wire or electromagnetic force. The hot wire principle has the advantage of great force of movement when contracting, but the disadvantage of involving a large time element, so that the corrective force is not applied instantly. Magnetic force, on the other hand, can be applied in a way to practically eliminate the element of time, and is, therefore, much more satisfactory. An arrangement, which in my experience has been very successful, is shown diagrammatically in the accompanying cut, and may be briefly described as follows:



Am.Elec.

DIAGRAM OF CONNECTIONS.

It consists of a solenoid having a fine winding for constant potential service, and a coarse winding for constant current service; a switch connected to the coarse winding serves to connect more or less of the convolutions of the coarse winding into the main circuit of the generator. The solenoid may be used on either direct or alternating current circuits. It has a laminated iron plunger or core supported by one arm of a lever, which has a counterbalancing weight at the other end, the counterbalancing weight being adjustable along the lever arm. The movement of the lever one way or the other from its normal position closes a pair of electrical contacts at one side or the other.

In operating such contacts where alternating current is used in the solenoid, it is found to be necesary to give the contact which is attached to the lever an elastic support. This may be done by mounting the platinum contact piece on one end of a short strip of thin spring brass, the other end of which is secured to the lever. When supported rigidly, the jar due to the alternations actually prevents the obtaining of an electrical connection at the contacts, even when the contact surfaces are apparently pressing hard together.

Having thus constructed a variation detector, we now need a connecting link between this and the rheostat, and here we require a uniform force of some considerable amount acting through a wide range, and one that can be controlled by the platinum contact points without undue sparking and burning. An ordinary magnet or solenoid large enough to do the work produces an induction spark at the contacts that is very formidable to deal with and actually forbids its use in practical work, but two differentially wound solenoids having a common core entirely overcome this difficulty.

Each solenoid has two windings, which are exactly alike, but connected in opposition to each other. Normally each solenoid has a current in only one of its two windings, and the iron core is, therefore, subjected to a magnetization by both solenoids and to two forces tending to pull it in opposite directions; but these forces balance each other and it remains at rest indifferently in any position where it happens to be. Now when the second coil in either solenoid is put in circuit by the contact points, the effect is to exactly neutralize the force of that solenoid and allow the other solenoid to move the core into itself; and when the circuit of the second coil is again broken at the contacts, there is no decrease in the magnetization of the iron core, but on the contrary a slight increase, and consequently there is no inductive spark.

It is really surprising to observe how effectually all spark can be removed from a set of contacts by this balancing of coils against each other; accordingly, the contact points are subjected to very slight wear, even though they may be controlling a large force. Of course, solenoids worked differentially and opposing one another, involve the expenditure of a double quantity of energy as compared with a simple solenoid, but it is perfectly feasible to operate the field rheostat of a 250-k.w. generator with a pair of differential solenoids, using only 42 watts of energy normally, and only 56 watts when moving the core. The question of watts wasted, is, therefore, trivial when compared with the immense advantage gained by a sparkless condition at the platinum contact points.

With any form of solenoid it is necessary to use some kind of retarding device, or it would move the rheostat too quick and cause racing. A most convenient and effective retarding device is obtained by mounting the two solenoids on a brass tube, inside of which the core is fitted as a piston. The tube is closed at each end and has a small pipe leading from one end to the other, with a hand valve in it. The tube and pipe are completely filled with oil or other liquid. The valve then serves as a means of adjusting the quickness of the movement, because the core can only move as it displaces the liquid in front of it.

Some electrical generators respond much more quickly than others to the movement of a field rheostat. Those with laminated fields respond quick, while those with massive solid fields respond slowly, and the question of quickness of regulation in every instance reduces to that of the quickness of response of the generator field, which may be one second and it may take several seconds. Alternators being usually constructed with laminated fields of comparatively small mass, are exceedingly susceptible to quick regulation and also to accurate regulation, by reason of the mechanical jar caused by the alternations in any coil through which they pass. The jar effectually removes the element of friction from pivots, and renders the variation detector exceedingly sensitive.

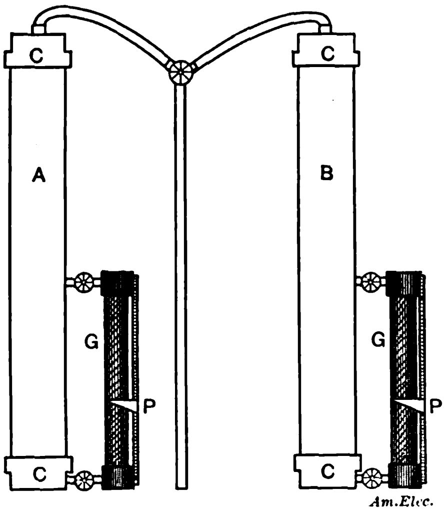
To render the detector solenoid free from temperature error it is important and feasible to put in circuit with it a resistance, which is a great many times as large as that of the solenoid itself, the resistance being made of material having a low temperature coefficient, like German silver, or else, one with a negative coefficient, like carbon, as the negative coefficient is favorable to sensitiveness.

In the case of alternating currents the resistance must be non-inductive, and the more there is of it the less liability there is of errors due to change of frequency, for change of frequency may easily prove a formidable source of error in plants subject to considerable speed variations, unless this matter of non-inductive resistance is carefully observed.

RELATIVE STEAM PIPE CONDENSATION TESTS.

BY REESE HUTCHISON.

While a student of the electrical and mechanical engineering course of the Alabama Polytechnic Institute, and following the suggestion of Prof. John J. Wilmore, professor of mechanical engineering, I made some tests to obtain the relative amount of steam condensation in two exactly similar iron pipes, except that one was highly polished and the other left rough.



STEAM CONNECTIONS.

Two 3-ft. 4-in. lengths of 2-in. iron pipe, A and B, were provided with caps, C. Each was provided with a 12-in. water glass gauge, G, having the customary valves for draining and cutting off from pressure. All joints were tight, and no loss of condensed steam was lost by leaks of any description.

Each pipe was clamped vertically in a vice and its water glass graduated to heights of water in the pipe, it being introduced in one fluid ounce quantities. One of the protecting rods of each glass was provided with a movable rider, the rod being marked at the successive heights of water in the glass. Before this graduation was started, each pipe was filled with water until the level was visible in the glasses. The amount and height in each pipe was the same.

When connected to the source of steam supply, all leading in pipes were inclined so as to allow any condensation in them to drain back from the test pipes.

A 5-h.p. test boiler, located in the foundry of the institute was used, a small auxiliary engine being run light to aid in pressure regulation. The steam passed to the test pipes through a 1-in. inclined pipe, and the test pipes were protected from draughts.

The steam pressure was kept constant at 100 pounds, it not varying ½ pound either way during the test. The height of water was also kept constant, thus rendering the steam practically of the same saturation in all tests.

As a preliminary, the pipes were "warmed up" by letting steam blow through the drain valve of each glass for at least twenty minutes. Then the bleed cocks were closed and water condensed to equal heights in the two pipes by means of a wet piece of waste. The test was begun by cutting off the glasses and allowing the steam to stand in the pipes for twenty minutes. Five tests were made for each condition, a mean being then taken. The rough pipe was provided with different qualities of commercial pipe covering, kindly furnished by the manufacturers mentioned below. More extensive experiments were prevented by the close of the scholastic year.

PIPE CONDENSATION TEST.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
No. of tests made. ...	5	5	5	5	5	5
Duration each test, minutes...	20	20	20	20	20	20
Mean steam pressure, lbs..... ..	100	100	100	100	100	100
Condensed steam, oz.:						
P'lish'd pipe	6½	6½	6¼	10.58	7	6¾
Rough pipe.	10⅛	4½	4¾	8.16	4.62	6.083
Ratio of condensation of rough to polished...	1:1.558	1:1.44	1.1.315	1:1.296	1:1.515	1:1.109

CONDITION OF PIPE TESTED.

No.	Condition Rough Pipe.	Material of Covering, etc.
1	Uncovered.	
2	Covered.	Asbestos Sponge Moulded Covering. Mfg. by H. W. Johns Mfg. Co.
3	Covered.	Firefelt Asbestos, Ditto.
4	Covered.	Not Branded—Philip Cary Mfg Co.
5	Covered.	Not Branded—Ditto.
6	Covered.	Cinders retained around pipe by iron jacket.

From these tests it might be inferred that the usual practice of equipping lubricators with polished water column pipes is against the scientific principles, as a rough pipe of shorter length would give similar results.

Electrical Journals.

To the Editor of American Electrician:

It is not quite correct to state, as does your corespondent John Horn, in your issue of April, that "the 'Telegrapher' was the pioneer journal" in the line of electrical or telegraphic information or news.

Edward Caldwell in your February issue is nearer the mark when he says it "was the first really successful paper in the United States devoted to the interests of the Electric Telegraph."

Exception may, however, be taken even to this statement, as it turns on the meaning and scope which each one of us may give to the word "successful."

The whole story of early American electrical journalism is told well, and with substantial accuracy, by James D. Reid in Chapter XLVII. of his "Telegraph in America," edition of 1879.

There, it is truly stated that three periodicals of this kind appeared before the "Telegrapher." The first of these was "The American Telegraph Magazine." A bound volume of this magazine is now before me, from which I learn that it was a monthly periodical, published in New York by Donald Mann; that Volume 1, No. 1, was published October, 1852; and that the last number, 6, having become a quarterly, asserts itself as being for April, May and June, 1853. Henry Brooks O'Rielly was supposed to be the editor, and the history of the magazine is told at length in the "Telegrapher," Volume 2, p. 75.

Next, came a quarterly, bearing the name of the "National Telegraph Review," edited by James D. Reid. It expired after four numbers had issued, forming a substantial volume of 400 pages. I have never been able to get hold of this, although I should like to; and so far as I can ascertain, there is but one copy now extant.

Then came a rather pretentious quarterly entitled "Shaffner's Telegraph Companion." Of this I have a copy. The first number is dated, January, 1854, and the last October, 1855.

These periodicals are all of great interest as preserving a record of facts and current news, of which otherwise there would be no account.

From 1855 to 1864, I believe no other attempt at telegraphic journalism was made. Then at a meeting of the National Telegraphic Union, an association of operators, the "Telegrapher" was founded. It became a good paper, was well run throughout, and existed until February 3, 1877. There are twelve volumes, all of which are in my business library.

It was the success of this paper which inspired some one behind Jerry Borst, to start the "Telegraphic Journal." As stated by your correspondents, everybody at that time believed the Western Union Company to be the inspiring influence in question. It was shortlived. Born March 7, 1867, and issuing weekly, it died in the arms of its friends in November of the same year.

From its ashes sprang the "Journal of the Telegraph," which from its incipiency was avowedly the organ and official instruction medium of the Western Union Telegraph Company. It was for many years a trustworthy and instructve journal of electrical events, and news; but with the advent of independent electrical journalism, and the widening field of electrical application, it gradually withdrew from its position as an electrical newspaper; retaining its functions as a tariff circular. I have also a complete file of this.

The "Operator" was started March 1, 1874, and has developed into the "Electrical World."

In conclusion I may say that it might be a good thing for that portion of the electrical public which interests itself in the historical side of the science, if Mr. Horn, your correspondent of April, would communicate with George C. Maynard of Washington, (who is Secretary of the Telegraphic Historical Society) with reference to his compilations regarding early telegraphic history; as that Society, I believe, wishes to get together, anything and everything it can, about the History of the American Telegraph.

Boston, Mass.

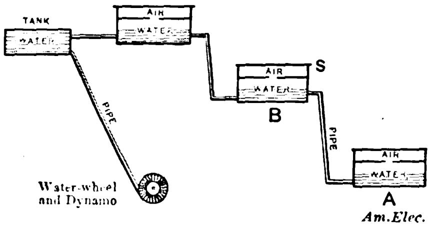
THOMAS D. LOCKWOOD.

A Sun Storage Battery.

To the Editor of American Electrician:

I have read the article entitled "Electricity," in the March issue, very carefully, and it seems to me to be in every way a most excellent one, and in marked contrast to the sensational and erroneous matter which has often been published under this heading. I concur entirely with the views expressed, and am glad occasion was taken to publish them, for the article will undoubtedly clear away the misconceptions which many have on this subject.

In one respect, however, I think a few words might have been said, i. e., in reference to the fact of the great trouble in handling chemicals for batteries, which make it appear to me that it would be preferable to attempt to use the sun's heat direct. As Langley has found, the sun radiates about 3 watts per sq. cm. per minute. Taking half of this we get 1,000,000 h.p. per sq. mile. Now, there are, even at present, means of utilizing a part of this. Take, for instance, a set of cells, shown in the accompanying sketch. W W are tanks of water, inclosed in glass roofed houses, like conservatories; S S are screens. First, open the screen of B, and close that of A. Let air in both. Then, open screen A and close the screen of B. The water will pass from A to B. If we assume the air in the glass roofed houses to reach a temperature of 50 deg. above the air, by painting its bottom and walls black, we may easily reach an efficiency of 5 per cent., the theoretical thermodynamic efficiency being about 15 per cent. Or, in other words, we might get about 50,000 h.p. per sq. mile in this crude way, which would have some slight advantages, as a pond of water at the top of a hill is the best kind of a storage battery, and more efficient than the forms now used, as 80 per cent of the power can be got back. I should be less surprised to see some plan like this used in certain cases, at first, than any other, though, of course, the above is only a very crude suggestion.



THERMAL STORAGE.

REGINALD A. FESSENDEN.

Allegheny, Pa.

Electricity.

To the Editor of American Electrician:

The article on "Electricity," which was printed in the March number of the "American Electrician," is admirable from many points of view. Among other timely things the author asserts that "electricity is popularly considered a mystery which has defied all the powers of science"; that "it is generally believed that marvelous developments await the answer to the question, What is electricity?"; that "the popular cry for a solution to the great mystery of electricity usually arises from the misconception that electricity is a substance, while in reality it is a mere word expressing nothing definite."

These assertions are true. And their truth emphasizes only the fact that the average electrical text-book is wofully inconsistent and misleading. The popular misconception that electricity is a "juice" is deplorable; but its existence will end only when students are no longer nursed on the nipple of the water-in-the-pipe bugaboo. As the writer stated in a serial on "Electrified Matter," which was begun in "Electricity" July, 1897, the real import of the terms volt, ampere and ohm is much more comprehensible when thus expressed:

Volt—Unit of effort to electrify.

Ampere—Unit of degree of electrification.

Ohm—Unit of persistency to remain unelectrified.

When we electrify a body we excite a conditional change therein; namely, we impair the cohesion of its molecules. The impairment of cohesion is induced by the impairing effort of the poles in contact with the body; the degree to which the cohesion is impaired by a given effort is dependent upon the resistance of the body, which consists of the persistency of its molecules to maintain their normal degree of compaction. Hence,

$$\text{Degree} = \frac{\text{Effort}}{\text{Resistance}}$$

Why should we labor over current when there is no current, over pressure when there is no pressure, or over the resistance to the passage of something when nothing is passing? The terms of electrical expression may be thought immaterial by some persons who understand the subject —and the subject is very much more understood than is popularly supposed. But Dean Alford's motto, "Call a spade a spade, not a well-known oblong instrument of manual industry," is a good thing for us to memorize.

HARVEY L. TYLER.

Corning, N. Y.

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ANNUAL REPORT OF THE GENERAL ELECTRIC COMPANY.

The following is an abstract of the eighth annual report of the General Electric Company, which was received too late for inclusion in the body of the paper:

PRESIDENT'S REPORT.

Schenectady, N. Y., April 25, 1898.

To the Stockholders of the General Electric Company:

The past year witnessed a revival in business which increased rapidly in activity and volume during its latter months. In the last annual report attention was called to the fact that your company began the year with less orders on hand than previous seasons. As a result of this the actual output of your work has been slightly smaller than in previous years, although the orders received during the period have shown a marked increase. This increase will be reflected in the shipments of the ensuing year.

A careful scrutiny of the assets of your company, other than its patents, leads to the belief that previous values were conservatively fixed and no changes of any significance have been necessary. The patent account of the company has been kept at substantially the same amount on its books since the organization of the company. The question of a revaluation of patents is one to which consideration should be given at the proper time.

The business of the year, given in detail elsewhere, has resulted in a reduction of the deficit of previous years by $1,231,852.37.

In addition to the purchase of $2,000,000 of debentures referred to in previous annual reports, your company has purchased during the year just ended $2,000,000, and the entire $4,000,000 have been destroyed. Since the books were closed $290,000 additional have been acquired and are now held in the treasury of the company. An increase is shown in the amount received from interest and dividends from securities owned. It is expected that the income from this source will still further increase from year to year, unless considerable sales of such securities should be made by the company.

The growth of your business has made it necessary to make further expenditures for additions and changes at your factories and in acquiring much additional machinery. Plans have been prepared and contracts partially closed for a new foundry and a large and important machine shop, the largest buildings yet erected by your company. In anticipation of the investment in the construction and equipment of these new shops, which it is estimated will cost about $500,000, the sum of $250,000 has been deducted from the profits of the past year and carried to the factory reserve account. It has been the practice of the company to write off the amounts expended for additional factory facilities. It is thought that these allowances are not more than are required to properly provide for depreciation in all your factory plants taken as a whole.

At the annual meeting of the stockholders, held four years ago, the question of reducing the company's share capital in the manner prescribed by law was referred to the directors. Since that time the matter has had the earnest attention of your board, and it is their hope that a plan will be submitted for your consideration at an early date, designed to provide for a suitable reduction of the share capital of the company, with a view to the resumption of dividends.

The patent situation has not materially changed since the last report to the stockholders. The company has secured many important patents during the year, by inventions of its engineers and experts and by purchase.

One of the Van Depoele trolley patents which had been uniformly sustained by the courts up to last summer has been adversely passed upon by the Court of Appeals for the Second Circuit. This decision was on a motion for preliminary injunction and is not final. The invention was an important contribution to the electric railway art, and no court has questioned its great merit. There is reason to believe that the technical objections to the claims of the patent, upon which was based the decision of the Appellate Court over-ruling that of the Circuit Court in favor of the patent, will be found upon full consideration at final hearing to be insufficient to defeat the patent. In view of the fact that nearly all of the railway companies in the country that would be likely to use the overhead trolley system are now electrically equipped, and that the third rail and underground conduit methods are being rapidly adopted for the important new enterprises, an adverse decision in this case will have but slight effect upon the business of your company. Many other cases based upon patented inventions of great value, including a number on the overhead trolley system, are being pressed against infringers, in which early and, it is believed, favorable decisions are expected.

Your directors desire to express their appreciation of the valuable service of your admiable engineering and commercial staff, as a result of whose ingenuity and vigilance the company has more than maintained its position of pre-eminence in the varied and constantly increasing applications of electricity.

By order of the Board of Directors.

C. A. COFFIN, President.

FIRST VICE-PRESIDENT'S REPORT.

Schenectady, N. Y., April 19, 1898.

C. A. Coffin, Esq., President:

I submit herewith a condensed report of the operations of the Sales Department for the fiscal year ending January 31, 1898:

Total sales (amount billed to customers)	$12,396,093
Cost of goods sold, general expenses and taxes, including sundry losses and allowances for losses	10,896,578
Profit on sales	$1,499,515

From this profit should be deducted debenture interest, etc., as shown in the report of the second vice-president.

I stated in my last report that "the orders actually booked in 1896 were considerably less than the orders secured in 1895." As a result, we entered upon the last fiscal year with less unfilled orders on hand than usual. Our orders during the first six months of the year were far from satisfactory; the second six months showed a very marked increase in orders, and as we were not able to increase our output to such an extent as to fill these orders within the limits of the fiscal year, we enter upon the present year with a larger list of unfilled orders on hand than ever before. "Sales" include the total billed amounts for goods actually shipped. "Orders" include business secured, and become sales only when the material is shipped and billed. Our sales for 1897 are somewhat less than our sales for the previous year, while our orders are considerably in excess of the orders secured in 1896. The following figures are based on orders secured and not on sales:

Lighting Department.—We have received during the past year orders for 60,826 k.w. capacity of arc and incandescent lighting machines as against orders for the year 1896 of 57,476 k.w. capacity, an increase of 5.8 per cent. Among the important lighting contracts secured during the year may be noted the equipment for the new station of the Brooklyn Edison Company and the equipment for the new station of the Boston Electric Light Company.

Railway Department.—Orders received (money value) for railway apparatus has shown an increase of 33⅓ per cent over 1896. Orders for railway generators aggregated over 60,000 k.w. The average size of the railway motor has increased to 34.7 h.p., while the average railway generator for 1897 was 484.3 h.p., as against 356.3 h.p. in 1896.

Among the important railway contracts secured during the year may be noted, the equipment of the Metropolitan Street Railway of New York City, the large motor order for the additional service of the Boston Elevated Railway (Lessees of the West End Street Railway), and the contract for the substitution of electric traction for cable traction on the entire system of the Capital Traction Company, of Washington, D. C. The development of interurban electric railway service has been a marked characteristic of the past year. This is well illustrated in the Cleveland & Lorain, the Akron, Bedford & Cleveland, and the Cleveland & Eastern Roads, each of which is equipped with powerful motors operated at speeds up to, and at times exceeding, 60 miles per hour.

Power and Mining Department.—The growth of business in the class of electrical apparatus handled by this department is strikingly shown by the following comparison of orders received for various years past:

Orders for 1893 were 36 per cent in excess of orders for 1892
" " 1894 " 126 " " " 1893
" " 1895 " 10 " " " 1894
" " 1896 " 60 " " " 1895
" " 1897 " 60 " " " 1896

Orders for direct current and induction motors aggregated

19.531 h.p., as against 15,171 h.p. in 1896. Orders for multiphase generators aggregated 49,902 h.p., as against 25,007 h.p. in 1896. Total transmission lines installed in connection with GE apparatus aggregated 326 miles, as against 232 miles in 1896.

Supply Department.—The supply department has handled 114,229 separate orders during the year, or 43 for each working hour. The "orders received" in 1897 exceeded by 20 per cent those of 1896. The supply stocks carried at our local offices have been decreased about 7 per cent during the year, and of the present total 90 per cent consists of active supplies, a great improvement over previous years.

The following are some of the principal articles handled by the supply department:

Wattmeters.—Total number ordered during the year, 36,874, an increase of 42 per cent over 1896.

Measuring Instruments.—Total number ordered during the year, 3369, an increase of 38 per cent over 1896.

Transformers.—Total number ordered during the year, 11,499, an increase of 36 per cent over 1896.

Arc Lamps.—Total number ordered during the year, 24,158, an increase of 75 per cent over 1896.

Sockets and Receptacles.—Total number ordered during the year, 2,357,629, an increase of 36 per cent over 1896.

Foreign Department.—The orders of the Foreign Department have shown a gratifying increase over the orders for 1896. Several notable contracts have been placed with us by our foreign companies—the equipment of the Central London Underground Railway, and the equipment of the street railways in several European cities.

Incandescent Lamp Sales.—The incandescent lamp orders for the year aggregated 6,857,239, of which 6,706,624 were shipped. This is an increase of about 10 per cent over the year 1896.

The success of the sales department is, in a great measure, due to the administrative ability and untiring energy of the department managers, and I desire to particularly commend their good work to your notice. Respectfully submitted,

EUGENE GRIFFIN, First Vice-President.

THIRD VICE PRESIDENT'S REPORT.

C. A. Coffin, Esq., President:

I submit herewith a report on manufacturing and engineering for the fiscal year ending January 31, 1898:

Our increased business in foreign countries has disclosed the fact that in design, cost and efficiency our machinery compares most favorably with that of European manufacturers. Valuable data, drawings, patterns and tools, necessitated by the large amount of special apparatus which we have successfully designed and manufactured in the past, are now frequently available in the construction of new apparatus, thus reducing the cost of developing such apparatus.

Engineering.—The number of undertakings requiring machinery of large capacity and special design has increased materially during the past year. This has been due largely to the application of electricity to the operation of underground, suburban and interurban railroads, and also to the concentration of power in large units due to the demonstrated economy of our three-phase machinery and the rotary converter mentioned in previous reports. A most notable and important installation is that of the underground Central London Railway, which we are equipping with three-phase generators, rotary converters and thirty-two large electric locomotives. Another remarkable undertaking is that of the mammoth new station of the Metropolitan Street Railway Company, of New York. From this station enormous electric generators will operate, through the medium of rotary converters and other machinery of our design and manufacture, the electric street cars throughout nearly the entire Borough of Manhattan.

In my last report I called attention to the value of our rotary converter, a species of connecting link between the alternating and continuous current systems which enables existing continuous current plants to add the advantage of alternating current generation and economical transmission to the simplicity and effectiveness of the continuous current distribution. The economies which thus result from the substitution of a single large alternating current power station for a number of small stations is well illustrated in a notable installation of such apparatus made during the past year by the Brooklyn Edison Company, using our three-phase generators, rotary converters, synchronous motors and other appliances.

The number of long distance transmission plants has greatly increased during the past year, so that we have now a total generating capacity in such plants of over 100,000 h.p., and among these some twenty installations are operating at potentials of over 10,000 volts and transmitting a total of some 50,000 h.p. to distances varying from ten to forty miles. The 5000 h.p. plant at Ogden, Utah, has been in operation for nearly a year, transmitting power to Salt Lake City, a distance of 36½ miles, at a potential of 16,000 volts. We have now under construction apparatus intended for the transmission of over 4000 h.p. from a distant water power 80 miles to the city of Los Angeles, Cal., at a pressure of 33,000 volts. The St. Anthony Falls plant, mentioned in my last report, has been completed and is now in regular operation, furnishing power to the street railways of Minneapolis and St. Paul, Minn. In the city of New Orleans, La., we shall soon have in operation a novel plant of some 4000 h.p., which will be used to operate pumps for the drainage of the city. Three-phase machinery will be employed. The driving of all machinery in cotton mills and factories by electric motors is increasing rapidly, even where the original source of power is a steam engine located in or near the mill or factory itself. The United States Navy is adopting the electric drive in place of steam or hydraulic machinery for ventilating, pumping and hoisting on shipboard and for lowering and elevating guns and for turning turrets on the warships. This is in addition to the recognized use of electricity for lighting and small power work.

We shall soon be operating our Schenectady works from a distant water power. We have contracted for a supply of 2000 h.p. from the Falls of the Hudson River at Mechanicsville, 10 miles from Schenectady. A novel feature of this transmission is that the generators, each of 1000 h.p., have been constructed by us to produce directly a pressure of 12,000 volts, thus saving the cost of the usual intermediate step-up transformers.

Our older transmission plants, such as Portland, Ore., and Fresno, Cal., operated with great success and have largely increased their capacity, demonstrating the advantages of our system and apparatus in the electrical utilization of water powers. There has been a great improvement in the efficiency and quality of our numerous small articles of manufacture, such as arc lamps, transformers, meters, switchboards, etc., many features of novelty and value having been developed by our engineers. Our business in this line has shown a gratifying increase. We have continued to protect our new and important engineering designs as far as possible by application for letters patent.

The efficient work of the factory managers and the unequaled ingenuity, skill and industry of our engineers, are worthy of special commendation. Respectfully submitted,

E. W. RICE, Jr., Third Vice-President.

SECOND VICE-PRESIDENT'S REPORT.

From the report of Second Vice-President J. P. Ord the following figures are taken and comparison made with reports of previous years:

CONSOLIDATED BALANCE SHEET.

Dated Jan. 31.	1895.	1896.	1897.	1898.
ASSETS.				
Patents and franchises	$12,059,263	$8,000,000	$8,000,000	$8,000,000
Factory plants		3,468,002	3,400,002	3,400,002
Real estate (other than factory plants)	423,787	453,585	643,016	586,529
Stocks and bonds	5,329,011	5,479,332	8,545,796	7,455,873
Notes and accounts receivable	5,508,499	6,584,123	4,578,601	4,537,301
Work in progress	846,291	961,386	517,866	283,832
Inventories	3,913,787	4,219,884	4,034,753	3,860,553
Cash	404,236	879,656	703,484	1,425,875
Miscellaneous, including Ft. Wayne Claims	1,176,666			
Profit and loss	14,294,717	13,917,071	12,957,413	11,725,561
Totals	$43,956,257	$43,963,069	$43,380,931	$41,275,526
LIABILITIES.				
Capital stock, common	$30,460,000	$30,460,000	$30,460,000	$30,460,000
Capital stock, preferred	4,252,000	4,252,000	4,252,000	4,252,000
5 p. c. gold coupon debentures	8,750,000	8,750,000	8,000,000	6,000,000
Accrued interest on debentures	72,917	72,916	66,666	50,000
Accounts payable	421,341	428,153	402,265	263,526
Mortgages			200,000	
Reserve for extension to factory plants				250,000
Totals	$43,956,257	$43,963,069	$43,380,931	$41,275,526

CONSOLIDATED PROFIT AND LOSS ACCOUNT.

Years ending Jan. 31.	1896.	1897.	1898.
EARNINGS.			
Sales	$12,730,058	$12,540,934	$12,396,093
Royalties and sundry profits	585,609	279,402	128,845
Interest and discount	100,784	88,336	90,371
Dividends and interest on securities owned	320,257	282,144	299,418
Profit on sales of stocks, bonds		79,817	116,356
Discount on debentures purchased and canceled		57,139	14,015
Balance forward	13,917,071	12,957,413	11,725,561
Totals	$27,653,779	$26,285,245	$24,770,660
EXPENSES.			
Balance from previous year	$14,794,717	$13,917,071	$12,957,413
Cost of goods sold	9,860,216	9,691,501	9,241,822
General expenses and taxes, sundry losses and allowances	1,926,819	1,834,419	1,654,757
Patents and patent expenses		349,919	333,335
Interest on debentures	437,500	431,250	333,333
Depreciation of inventories	101,191	50,355	......
Depreciation of consignments	22,013	10,730	......
Written off	511,322	......	......
Reserve for factory extensions	......	......	250,000
Totals	$27,653,779	$26,285,245	$24,770,660

NOTES.

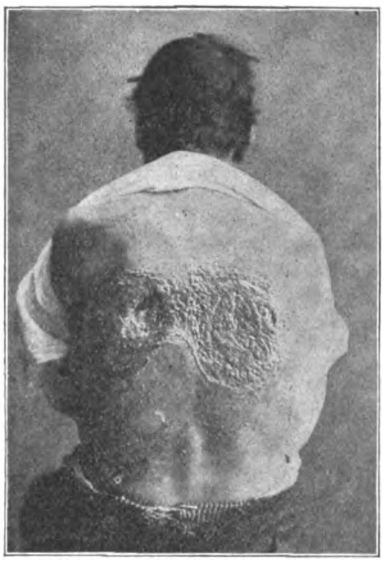
The Van Depoele Trolley Patent.—The U. S. Circuit Court of Appeals, Second District, has declared invalid the two claims of the celebrated Van Depoele under-running trolley patent, which had survived previous litigation, thus bringing to a close the most important episode in electric railway patent litigation. The patent contains sixteen claims, and the final ones annulled relate to the pivoted trolley arm, movable on both a vertical and a transverse axis. The grounds upon which the decision was based were that the two claims at issue are for the same combinations specified in some of the claims which have been declared void. The owners of the patent state that they will push the case to final hearing, the present decision having been made under proceedings for a preliminary injunction.

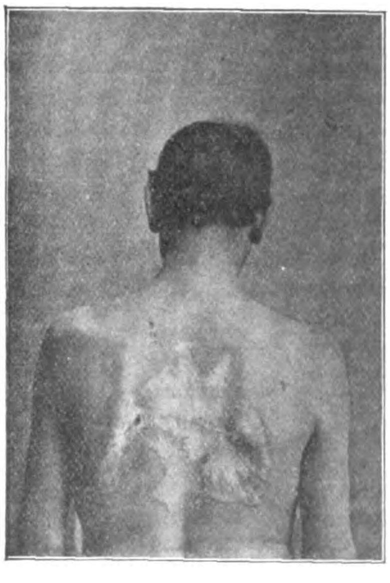
The Electrical Exhibition.—The New York Electrical Exhibition, which will have opened its doors by the time this issue reaches many of our subscribers, gives every promise of securing a success highly creditable to the industry represented. The special features arranged for are so numerous that their mere mention would require more space than is at our disposal, and it is perhaps sufficient to say that a visitor to the exhibition will find, aside from the trade exhibition, enough to keep his attention occupied for hours. One of the latest features arranged for is a series of eight tableaux designed to mark the more important successive stages of early electrical development. The tableaux have been executed and arranged by the Eden Musee Company under the direction of Dr. Park Benjamin and Prof. F. B. Crocker, and will include scenes including Gilbert, Stephen Grey, Benjamin Franklin and others. A complete model exhibit will be made of the Edison magnetic iron ore separation process, together with samples of material in its various stages. In the instrument department Dr. Shelden will have a loan exhibit of electrical standards, including some from the German Reichsanstaldt.

Charges for Electric Power.—The Cataract Power and Conduit Company, of Buffalo, which will distribute Niagara power in that city, has established the following rates for power service: First, a "service charge" of $1.00 per k.w. on the amount of power which the user may require the company to keep available and ready for use—this amount corresponding to the "maximum demand" of the Wright system of charge. Second, a "power charge," depending upon the actual amount of power used, as determined by meter. This charge per k.w.-hour is as follows: Not exceeding 1000 units, 2 cents per unit; exceeding 1000 units, but not exceeding 2000 units: for 1000 units 2 cents per unit, and for the excess 1.5 cents per unit. Exceeding 2000 units, but not exceeding 3000 units: for 2000 units 1.5 cents per unit, and for the excess 1.2 cents per unit. Exceeding 3000 units, but not exceeding 5000 units: for 3000 units 1.2 cents per unit, and for the excess 1 cent per unit. Exceeding 5000 units, but not exceeding 10,000 units: for 5000 units 1 cent per unit, and for the excess .8 cent per unit; exceeding 10,000 units, but not exceeding 20,000 units: for 10,000 units .8 cent per unit, and for the excess .75 cent per unit. Exceeding 20,000 units, but not exceeding 40,000 units: for 20,000 units .75 cent per unit, and for the excess .7 cent per unit. Exceeding 40,000 units, but not exceeding 80,000 units: for 40,000 units .7 cent per unit, and for the excess .66 cent per unit. Exceeding 80,000 units: for 80,000 units .66 cent per unit, and for the excess .64 cent per unit.

Philadelphia Electrical Exhibition.—Besides the other many special features of the Philadelphia Electrical Exhibition, arrangements are being made whereby the most attractive features of the New York exhibition will be transferred to Philadelphia, the exhibition there opening at the conclusion of the one in New York. Special arrangements have been made for the elaborate decoration of the building, and the managers hope in this respect to surpass anything that has yet been done. An electrical cataract is almost completed, which is a reproduction of one used with great success at the Opera Ball in Paris. Among the attractions will be the kinetoscope, the cinematograph, and an X-ray apparatus, which will be constantly in operation in connection with a screen. An electrical fountain, with kaleidoscopic effects produced by rapidly moving lights, is now being built. Arrangements are being effected for the use of large quantities of decorative foliage plants in connection with electric lights. Phonographic speeches have been secured from distinguished inventors and electricians, and these will be reproduced at regular intervals. The exhibition will open on June 6.

Treatment for Electrical Burns.—The New York "Medical Journal," in a recent issue, printed an account of the treatment of a severe case of electrical burn, which we reprint below. Through the kindness of Mr. S. A. Rickard, of Saratoga Springs, New York, we are enabled to add two illustrations, showing the condition of the patient before and after treatment. Following is the account of the case, as furnished to our medical contemporary by Dr. J. F. Weathers, of New Albany, Ind.: An electrician employed in the electric plant used to furnish power to the city street-car line and to the arc and incandescent lights for the city accidentally brought his back in contact with the positive and negative keys of the switchboard of arc line furnishing ninety-six street lamps and carrying 4000 volts of electricity. He became impaled, so to speak, on those keys, until he was released by the tissues being burnt away in two pits about 3 ins. in diameter and down to the bony structures. The intervening space between these pits, which were 10 ins. apart, was roasted, and after the lapse of a few weeks was lifted out. It weighed 2½ lbs. I was called to see him immediately after the accident, which was on April 12, 1897. I applied linseed oil and limewater, equal parts, pouring the charred cavities full and covering them over with absorbent cotton. I kept this up some days. I administered opiates to relieve pain, which was quite severe. The sloughing was something awful; the cotton, bandages, clothing and bed were saturated in pus. I turned my attention to some dry dressing, and first used boric acid and bismuth subnitrate, but this produced too much pain. I then tried the antiseptic known as vitogen, sprinkling the powder lightly over the surface, and over all a cloth saturated with linseed oil was laid. The effect was marked; quietude and sleep followed without the administration of an opiate. This dressing was repeated generally twice a day for many days, and one remarkable feature is that I saw no more pus, and on undressing the wound there was visible no vitogen powder. This treatment was never departed from until September 1st, when the patient was discharged. I used 18 ozs. This man withstood 4000 volts, as all the arc lamps were extinguished for the time.





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The Electrical Exhibition.

The electrical exhibition which opens May 2 in Madison Square Garden, New York, promises to be by far the best electrical show yet presented to the public, both electrical and non-electrical. Aside from the commercial exhibits, the former will find many special features of interest, including models of the open conduit electric railway system adopted in New York and Washington, the third rail system in use on several New England roads, the Sprague multiple unit system, a working exhibit of the Marconi wireless telegraph, etc. The educational features for the general public are particularly numerous and well conceived, in this respect the exhibition performing a worthy work in the better interest of the electrical industry.

Heat Storage.

In another column will be found an interesting letter from Prof. R. A. Fessenden on heat storage, which points out one method whereby in the far future the heat of the sun may be stored for final transmission into electrical energy. In this connection it may be remarked that Ericsson spent the latter years of his life working on the problem of the industrial utilization of the heat of the sun directly, having in view, he said, not present needs, but the time some centuries hence when the world's supply of fuel shall be exhausted. The method suggested by Prof. Fessenden has a present interest as an illustration of a simple transformation of the energy heat into work.

The War.

Warfare, besides its beneficial effects in stimulating, when waged in a good cause, the nobler nature of a people, has also in these days when every branch of engineering is represented in the art of war, its technical lesons to teach. Next to contractors, yellow journalists and jingo politicians—though in not so selfish a relation—electricity has the most promise of material benefit from the war now upon us, for one of the lessons that will undoubtedly be taught in naval action is the desirability of further extensions of electrical power aboard ship. A few auxiliary steam pipes severed by shot will involve an object lesson not to be passed by; and the monstrous ventilating systems installed on some ships, with their conduits of a square foot or more sectional area and passing through water-tight bulkheads, may lead to disaster in case of the flooding of a compartment that will bring about a full recognition of the advantage of an electrical blower service. An impetus will also be given to electrical signalling without wires, at least one promising system of which has already been submitted to war officials. It is also gratifying to electricians to know that one of the most powerful defensive means on a modern warship is the electric searchlight, without which night would be a time of terror aboard a naval vessel, comparatively defenceless as she would be against torpedo attack.

Condenser Action and Synchronous Motors.

When the transmission of power first began to assume importance, it was thought that line inductance would be a serious factor, owing to the loss of voltage through inductive drop. Happily it has been discovered that where synchronous motors can be used, this drop may not only be nullified, but also ohmic drop and, in fact, that the voltage at any desired point may be regulated within considerable limits independently of the generator voltage. Since the rotary converter, as usually designed, is a synchronous motor with respect to the alternating current line side, this method of regulation has a wide field of application. While a complete explanation of the principles involved would be difficult to give in simple terms, the understanding of the action is easy if it is borne in mind, first, that a condenser current leads the impressed e.m.f., and, second, that in connection with an inductance a condenser may act as a step-up transformer.

In a synchronous motor circuit there are three e.m.fs.—the impressed e.m.f., a motor counter e.m.f., and an e.m.f., due to the inductance of the armature, and the current flowing will be a resultant of these three factors. Now, if such a motor is so designed that the resultant of these e.m.fs., and, consequently, the current, will lead the line e.m.f., then the motor will be analogous to a condenser in circuit. The field of a synchronous motor is maintained by a direct current taken from a source independent of the source of the armature current, or, in the case of a rotary converter, from the commutator circuit, and in either case its value may be regulated at will. On the other hand, the armature of the motor must run at a speed fixed by the frequency of the alternating current line. We thus see that the counter e.m.f. factor can be regulated at will, and it happens that for a given load (or any smaller load) it may be varied between wide limits without affecting the working of a machine. It has been shown by Steinmetz in "Alternating Current Phenomena" that with a field excitation having a certain relation to the impressed and inductive e.m.f., a synchronous motor may be made to take a current having a definite lead over the impressed e.m.f. That is, such motors may be designed so as to have a condenser effect and thus be capable of regulating the line e.m.f. entirely independent of the generator.

In the following article it is shown how a condenser in series with an inductance may act as a step-up transformer. In the case here considered, the inductance may be that of the line between the generator and motor, in which case the latter, if so designed, will raise the voltage at a point immediately on the other side to an equality with the generator voltage. Or, by placing an additional inductance in the generator side of the line, the voltage beyond the motor can, with a proper design of the latter, be raised to compensate also for the ohmic drop, or even to a voltage above the generator voltage. Moreover, by varying the motor field excitation, the amount of the voltage increase may be varied within limits. In the case of the plant at St. Anthony's Falls, a description of which appears elsewhere in this issue, the line voltage is thus over-compounded by means of inductances in connection with rotary converters.

Inductance and Capacity.

Were it possible to make condensers as reliable as, say, transformers, an entirely new field and a most interesting one would be opened up in alternating current working. While experience with condensers in commercial working has hitherto been unsatisfactory, one would be rash indeed to assert that the defects they have developed cannot be overcome. Thus far what work has been done in the attempt to adapt the apparatus to alternating current working appears to have closely followed old lines of construction, and owing possibly to the supposed recondite nature of capacity phenomena, the subject has received but little attention from the professional inventor. There is scarcely any branch of alternating current working in which the condenser could not be commercially applied with benefit, and it is to be hoped that its commercial perfection will soon receive the attention that its importance warrants, and which in the past it has not received.

To appreciate the role of the condensers in alternating current working, the relation between inductance and capacity must be understood. Whenever an alternating current flows in a circuit, a counter e.m.f. is set up, due to the cutting in and out of the circuit of the lines of force corresponding to the successive values which the current assumes. As the current varies in value the number of lines due to it also varies, so that at one instant the circuit will contain more or less lines than at the preceding or succeeding instant, the resultant effect during an entire cycle being the generation of an e.m.f. counter to the impressed e.m.f. The case may, in fact, be considered exactly analogous to that of the generation of counter e.m.f. in the armature of a constant current motor. In each case an e.m.f. is generated by the cutting of a conductor by lines of force—the conductor being movable and the lines fixed in that of the motor, and the conductor fixed and the lines movable in that of the alternating current circuit. We here speak of the resultant effect, for whereas while the current is increasing the inductive e.m.f. is counter to the impressed e.m.f., when decreasing it is the same direction. Were there no difference in phase between the impressed and inductive e.m.f., what would be lost in one part of the cycle would be gained in the other, and no counter e.m.f. would result. It can, however, be very simply shown, first, that the inductive e.m.f. must differ in phase from the impressed e.m.f., and, second, that this difference gives rise to a resultant opposing the impressed e.m.f., but this will here be taken as granted.

The action of a condenser in an alternating current circuit might also be explained with reference to lines of force, but it is perhaps simpler to view it from another standpoint—the capacity of a condenser for absorbing current when the difference of potential is raised between its terminals, and discharging current when this difference is lowered. For example, as the e.m.f of an alternating current containing a condenser is increased, the difference of potential between the condenser terminals is also increased, and a charge flows into it corresponding to its capacity, the frequency and the change in potential. Now, this charge is in the same direction as the main current, and consequently is equivalent to the introduction into the circuit of an e.m.f. in the same direction as the impressed e.m.f., and corresponding in value to the condenser current thus set up; on the other hand, when the circuit e.m.f. decreases, a current is discharged into the circuit against the main current, which is equivalent to the introduction of an e.m.f. opposing the fall of impressed e.m.f., and corresponding in value to the condenser current. As, however, the impressed and condenser e.m.f. differ in phase, the resultant effect during an entire cycle will be, as in the case of an inductance, an e.m.f. opposing the impressed e.m.f., its value depending upon the capacity of the condenser for a given frequency.

From the above it will be seen that while with a rising e.m.f. an inductive e.m.f. opposes the impressed e.m.f., a capacity e.m.f., on the contrary, acts in the same direction; and that with a falling e.m.f., while the inductive e.m.f. acts in the same direction as the impressed e.m.f., a capacity e.m.f. acts in the opposite direction. If this relation is borne in mind, every application of the condenser in alternating current working may be clearly understood.

For example, suppose we take for illustration the case of a choke coil placed between the mains of a 100-volt constant potential circuit. Furthermore, assume that the ohmic drop due to the current passing is relatively negligible and that the current flowing through the coil is 2 amps. If now we place in series with the coil a condenser, since the e.m.f. set up in the latter is, with both a rising and falling current, opposite to that set up in an inductance, part of the inductive e.m.f. will be nullified, and consequently more current will flow through the circuit, say 4 amps. But as the inductive e.m.f. between the terminals of the coils varies directly with the current flowing through it, this will have become 200 volts, or double that of the circuit. Suppose now that a condenser is chosen of such a capacity that for the same current flowing through both the condenser and coil, the inductive e.m.f. will equal the capacity e.m.f. Then when placed in series, the e.m.f. of one will nullify that of the other, and the current flowing will be that corresponding to the ohmic resistance alone. If this is 1 ohm in the above case, the current will be 100 amps., and consequently the e.m.f. between the terminals of either the condenser or choke coil will be nearly 5000 volts, though that of the circuit is but 100 volts. If there were no resistance in circuit, the current and both the inductive and capacity e.m.fs. would be infinite, or the circuit would be a so-called resonant circuit—though why this particular name should be given is not clear, since it is merely made a short circuit through the reactance being reduced to zero.

From what precedes it will be seen that by the use of a condenser of proper capacity in series with an alternating current motor, the inductance of the latter may be nullified so that to the passage of an alternating current no more resistance will be opposed than if it were a direct current; and it can be shown that the same effect will be produced by inserting a condenser in parallel with the motor. Similarly, a condenser may be used in connection with an inductance as a step-up transformer. If placed in an alternating current line, the inductive drop may be nullified, or both the inductive and ohmic drop, or even the voltage at the end of the line raised above the generator voltage. Where concentric conductors are used this latter effect, in fact, may occur through the high capacity due to such an arrangement of conductors. Another interesting application of condensers and inductances, following to the principles herein explained, will be found on page 222.

A UNIVERSAL MOTOR AND DYNAMO.

The majority of amateurs and experimenters are so situated that they are unable to command a supply of both alternating and direct current, and many of them have neither at hand. It is principally for the benefit of those who are so circumstanced that the little machine described here was designed, since it seems to combine in a small compass ability to serve most of the purposes of the experimenter, and, at the same time, requires no great mechanical skill for its construction. Its cost, especially when most of the work upon it is done by the owner, should be very small considering its usefulness and capacity.

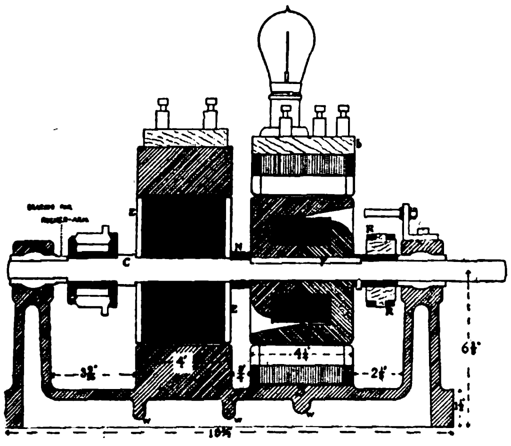


FIG. 1.—LONGITUDINAL CROSS SECTION—WINDINGS NOT SHOWN.

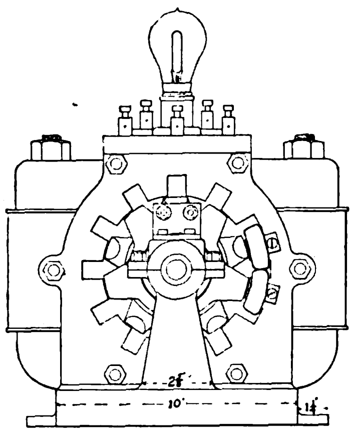


FIG. 2.—ELEVATION OF ALTERNATOR END—TWO COILS OF A. C. ARMATURE SHOWN IN PLACE.

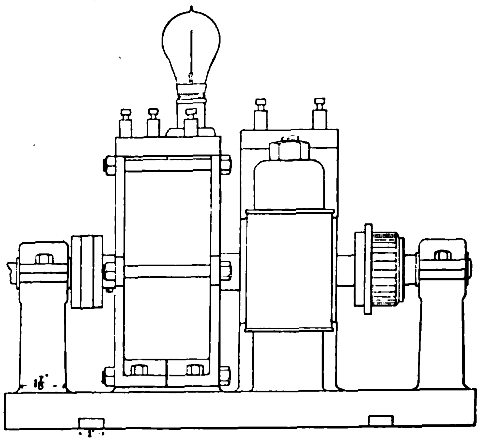


FIG. 3.—SIDE ELEVATION—D. C. BRUSHES, A. C. AND D. C. ARMATURE WINDINGS AND COLLECTING BRUSHES NOT SHOWN.

The machine consists of a small alternator and a direct current motor or dynamo of equivalent dimensions, coupled together and furnished with a pulley for applying or withdrawing power. With the dimensions and windings here given it can be put to the following different uses:

1. Direct current 110-volt 1-h.p. motor.

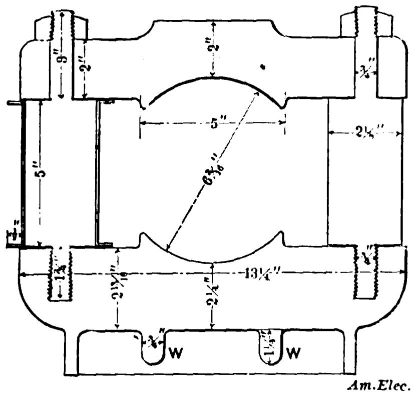


FIG. 4.—CROSS SECTION OF FIELD D. C. PART, SHOWING ONE SPOOL IN PLACE.

2. Direct current dynamo, giving 110 volts and 8 amps.

3. Motor dynamo, taking 100 volts and 10.8 amps. direct current and giving 110 volts and 6 amps. (single-phase) alternating current at 7200 cycles per second.

4. Alternating current, self-excited generator, giving 110 volts and 6 amps. (single-phase) at 7200 cycles per second.

5. Synchronous motor, giving about ¾ h.p. at 1200 r.p.m. with proper single, two or three phase alternating current supply.

6. Motor dynamo, taking alternating current and giving direct current at 110 volts.

7. Double-ended dynamo, giving at the same time both alternating and direct currents.

8. As generator, synchronous motor, motor dynamo in either sense, or double-ended generator, giving or taking two-phase or three-phase alternating currents.

Its construction is clearly indicated by the accompanying engravings. Fig. 1 is a longitudinal cross-section, Fig. 3 is a side elevation and Fig. 2 an elevation of the alternator end.

The base casting carries the two pedestals for the bearings and the lower yoke of the direct current end. Its design may, of course, be modified to suit the taste of the maker, but that given in the illustrations is simple and strong, and easy to cast. It would be better on some accounts to make the pedestals carrying the bearings separable from the bed casting, but this would involve planing four surfaces, boring and tapping eight holes and considerable care in the fitting and alignment of the parts, so that the pedestals are shown, for the sake of simplicity, cast integral with the bed. The webs W W (Figs. 1 and 4) should run entirely across and lengthwise of the bed, respectively, serving to stiffen it and to avoid any deformation due to unequal cooling in the mould. The hollow pedestals might, with advantage, be closed at their bases and provided with small drain-cocks, so that the oil used in the bearings, after passing through them, may collect and be used again. The surface S (Fig. 1), upon which the stationary alternator armature rests, should be cast about ⅛ in. higher than it is to finish, and planed off to a proper height for lining up the machine when it is assembled, as will be described below.

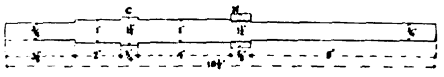


FIG. 5.—THE SHAFT.

The bearings may be of any convenient form, that shown being a simple self-lining variety, the brass bushing carrying a spherical central part fitting in seats milled, or coned with the point of a large twist-drill, in the pedestals and the covers. The bushing at the commutator end is made ½ in. longer than the other, and turned down, as shown, to form a bearing for the brush-holder rocker arm. This should be straight and may be of any convenient design, as may also the brush-holders. Copper leaf brushes should be used, set at opposite points on the commutator. The lines of commutation will be nearly horizontal.

The shaft is of good machin[illegible]teel, its dimensions being given in Fig. 5. It is easily made by turning down a piece of 1½-in. shafting, or a piece of 1⅛-in. may be used, and the collar C pinned or shrunk on; but this construction is not so good as the other. The nut N is an ordinary hexagonal nut, which is turned off round after the armature is assembled ready for winding.

The direct current armature core is composed of two stout end pieces of steel or brass (E E Fig. 1) and charcoal iron discs, 6 ins. in diameter and not more than 1-32 in. thick. It is slotted with thirty-six slots parallel to the shaft (Fig. 6), each slot being 9-32 in. wide and ⅜ in. deep, and is provided wth a key-way ¼ in. wide by ⅛ in. deep. The slotting may be easily done on a milling machine, the discs being first assembled on the shaft (which should be steadied with blocks at each end of the armature core to prevent its springing) or the discs may be

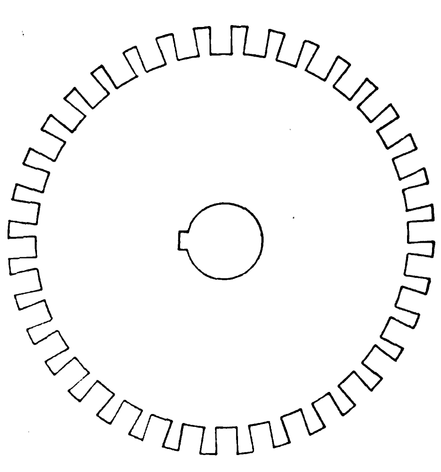
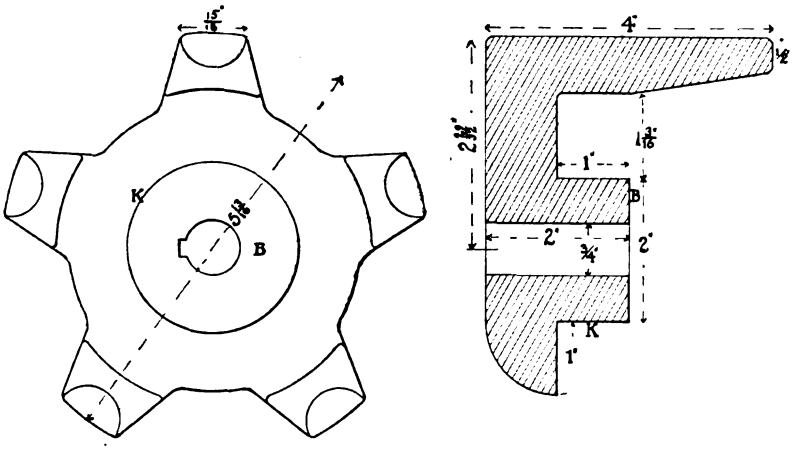


FIG. 6.—AN ARMATURE DISK.

bought of the proper shape. If they are milled the core should be taken apart and the discs annealed, after brushing off any burrs due to the milling, by heating them to a dull red heat and cooling slowly. They should then be shellaced or japanned lightly and reassembled, the nut N being set up as tight as possible without stripping the threads, and then turned off round and smooth to the size given in Fig. 5. The sharp edges of the slots in the end plates should be brushed off with a file and the whole core given a coat of thin shellac and baked (a cooking-stove oven answers admirably for armature and coil baking, but should not be made too hot).



FIGS. 7 AND 8.—ELEVATION AND CROSS SECTION OF ONE PIECE OF A. C. FIELD.

The cores of the field magnet are made of round iron shafting, the softest that can be had, 2½ ins. in diameter. Two pieces, each 9⅞ ins. long, are cut off and turned up and threaded, as shown in Fig. 4. Holes are drilled and tapped for their reception in the lower yoke of the bed casting, as shown, and the upper yoke casting bolted in place. The surfaces of both upper and lower yokes, where the shoulders of the field cones abut, should be planed flat, and extra care in fitting these will be well repaid by the better performance of the machine. The top of the upper yoke is tapped to receive countersunk screws holding the hard-wood or fiber base for the four binding-posts shown in Figs. 1, 2 and 3. Spools for the field winding are made of brass, using thin mandrel-drawn tubing for the cylindrical part, or, if this cannot be had, 1-32 in. sheet brass, bent to shape around the core, and soldered. The ends are brass rings, soldered on, all four being easily made at the same time by soldering together four pieces of ⅛-in. sheet brass, boring out the center, mounting them on a mandrel, turning down the outside and melting them apart. The spool should be covered with about two layers of cotton cloth, put on with thick shellac, and well baked before winding. The ends should not be less than ⅛ in. thick, and should be scored 1-16 in. deep to form a channel for bringing out the inside end of the winding.

The commutator has thirty-six bars, 1 in. width of face and 1 in. bore. It should be not less than 3 ins. in diameter and is best bought, though the amateur can make it if he has the time and necessary tools. It is held fromturning on the shaft bya feather (not shown in the drawings) and sufficiently held endwise by the wires soldered in it. It should go flush against the shoulC of the shaft.

The alternator is of the type described by Professor Henry S. Carhart in "The American Electrician" of November, 1897, and is here modified from his excellent design only in size and to adapt it to the purposes of this machine. It is urgently recommended to those who construct this machine that they first read Professor Carhart's article.

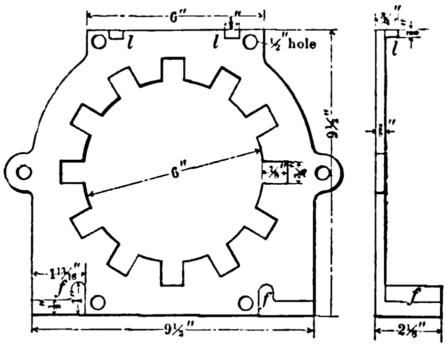
The field revolves and consists of two five-pointed star-shaped iron castings (Figs. 7 and 8), exactly alike, mounted facing each other on the shaft with their fingers interlaced. A key-way is cut in each to receive a feather on the shaft (F Figs. 1 and 5), so that the ten fingers are spaced at exactly equal intervals around the circumference when the field is assembled. The abutting surfaces, B, Figs. 7 and 8, should be turned off true in the lathe, and the outer surface of the core, K, Fig. 8, should be turned off to size to receive the spool carrying the winding. This spool is made in the same way as those already described, its dimensions being 2 ins. inside diameter, 2 ins. long over all, and 1⅛ ins. deep to contain the winding.

After assembling this 10-pole field its exterior should be turned off to a diameter of 5 13-16 ins. All sharp corners should be neatly chamfered off with a file after it is turned up.

The two collector rings, R R Fig. 1, are of brass, about 3 ins. outside diameter, turned up smooth and driven on a hub or hard-wood or fiber; wood being the better because it is less liable to shrink. They may be pinned in place, but a little bicycle tire cement will be found to hold them excellently. The hub should be trued up in the lathe after it is in place on the shaft, and given a coat of shellac to keep out moisture. The two ends of the field coil are led in small rubber tubes (⅛ in. diameter may be had at most drug stores) and soldered into small holes in the edges of the collector rings. Of course one wire goes through the hub to the side next the bearing to connect with the outer ring.

The alternator armature is stationary, and is wound with twelve coils. It consists of soft iron discs, held between two cast iron end plates, shown in elevation in Figs. 9 and 10, Fig. 9 showing the side next the discs. These end plates are provided with feet (f f Figs. 9 and 10), which abut when the two plates are drawn together by the six bolts connecting them. At the upper part of the end plate are two lugs (l l Figs. 9 and 10), which are tapped to receive the screws holding the wooden block b (Fig. 1), which carries the eight binding posts and lamp socket shown in the drawings. The discs are 6 ins. inside and 9½ ins. outside diameter, and may be bought of this size. They should not be heavier than No. 24 gauge. To assemble the armature the lower surfaces of the feet f f should be planed true, and their abutting surfaces finished off, the bolts put in place in one of the end plates, the discs laid in the cage formed by the six bolts, and the other end plate put on and bolted up tight. The nuts should be tightened evenly all around the circumference until the feet abut fairly against each other, the whole being set on a flat plate and gently tapped with a mallet, so that all four feet will bear evenly. The twelve slots, each ¾ in. wde and ⅞ in. deep, should then be milled out and the discs taken apart and treated in the same way as those of the direct-current armature described above. A score should be filed or sawed in the bottom of one of the slots before the discs are dismounted for annealing, etc., so that they may be put together in the same way when reassembled.

If the shop in which the work is done has no milling machine, the slot may be planed out or worked out on a small shaping machine. It is possible to get very satisfactory results with a hack-saw and chisel, by sawing two cuts of the right depth for the side of each slot and chipping out the metal with a sharp chisel ground off to the right width. If care and time be taken, a very neat job can be made by this primitive means.



FIGS. 9 AND 10.—INNER SIDE AND EDGE ELEVATIONS OF A. C. ARMATURE FACING CASTING.

After the bearings are in place, the direct curent field should be put together and bored out. A boring bar running in the bearings is by all odds the best tool to use for this. To make this bar take a piece of 1½-in. shafting 24¾ ins. long, turn down the ends to a diameter of ¾ in. for 8½ ins. at one end, and 6½ ins. at the other, so that it may run in the bearings of the machine and at the same time slide through them endwise. Cut a slot through the bar, for the reception of a lathe tool 3 ins. from the shoulder next the long bearing surface, and put in a set-screw to hold the tool. Then block up the machine, with the boring bar in place, in the bearings, on the the carriage of the lathe, so that the boring bar may be driven in centers, the dog being put on the long bearing end. Very light cuts are taken, the diameter of the bore being finished to 6 3-16 ins. All resulting sharp corners and edges should be filed off. Of course the field may be bored in other ways than that described, but it will be found that the method given is accurate and easy.

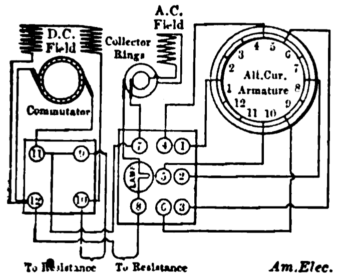


FIG. 11.—CONNECTIONS, BINDING POSTS AND CIRCUITS.

The surface S (Fig. 1), on which the base of the alternator armature rests, may now be planed down and the armature set on it and lined up. It is advisable to have the holes in the feet of the armature somewhat larger than the cap screws which fasten it to the bed, to allow a little adjustment sideways.

The windings for 110 volts at the direct current end and the same voltage (single phase) at the alternator end, with a speed of 1200-r.p.m. and a corresponding frequency of 7200 cycles per second are as follows:

1. Direct Current Field: Fill each of the two spools neatly full of No. 24 B. & S. gauge double cotton-covered wire, putting in not less than 18 layers on each. The spools should be covered with cotton cloth, well shellaced and baked, before winding. About every third layer of wire should be shellaced and the finished coils should be baked at a low temperature for several hours. They must be put on the field cores with the ends of the winding uppermost, the outer end of one coil and the inner end of the other being connected to the two binding posts, numbers 10 and 12 (see Fig. 11), and the other two ends connected together, the connection being covered with a piece of ⅛-in. rubber tubing. It is a good plan to solder a piece of No. 16 wire a few inches long to the inner end of the coil winding, running this down through the score in the spool head to the cylindrical part and allowing the small wire winding to begin there. This obviates the danger of breaking off the inner end of the coil.

2. Alternator Field: This spool is also wound full of No. 24 double covered wire, at least 34 layers being put on. It is connected directly to the two collector rings as has been described above.

3. The Direct Current Armature: This is wound with 36 coils, each containing 8 turns of No. 16 wire, making 16 wires in a slot. The slots are first insulated with little gutters of thin micanite or fibre, shaped around a square cornered bar and forced into the slot. The heads of the armature under the slots and the shoulder C and nut N on the shaft are covered with cotton cloth shellaced on. The simplest winding is the best. Commence at the commutator end of any slot, making first a small loop in the end of the wire to identify the inner end of the coil, and wind over the armature endwise and through the opposite slot four turns, always going to the same side of the shaft, then four more turns going to the other side of the shaft. The first four will fill the bottom of the slot and the next will go in on top of them. Then turn the armature over and begin another coil in the slot next to that opposite the first slot. When 18 coils have been wound every slot will have 8 wires in it. Proceed with 18 more coils on top of these and the armature winding is finished. If the slots are numbered consecutively 1 to 36, the coils will begin as follows:

Coil	1	in	slot	1	Coil	19	in	slot	19
"	2	"	"	20	"	20	"	"	2
"	3	"	"	3	"	21	"	"	21
"	4	"	"	22	"	22	"	"	4
"	5	"	"	5	"	23	"	"	23
"	6	"	"	24	"	24	"	"	6
"	7	"	"	7	"	25	"	"	25
"	8	"	"	26	"	26	"	"	8
"	9	"	"	9	"	27	"	"	27
"	10	"	"	28	"	28	"	"	10
"	11	"	"	11	"	29	"	"	29
"	12	"	"	30	"	30	"	"	12
"	13	"	"	13	"	31	"	"	31
"	14	"	"	32	"	32	"	"	14
"	15	"	"	15	"	33	"	"	33
"	16	"	"	34	"	34	"	"	16
"	17	"	"	17	"	35	"	"	35
"	18	"	"	36	"	36	"	"	18

As each coil is wound the two ends may be twisted together for the moment. When all 36 have been wound there will be 36 pairs of ends sticking out, one end of each pair being distinguished by a loop to indicate the beginning or inside end of the coil. The commutator is now put on, and into the slot in the tail of each bar is soldered the inside end of one coil and the outside end of its next neighbor in regular order around the armature.

Where the coils cross each other on the ends of the armature strips of muslin should be laid between them. Each coil should be shellaced as it is wound, and when the first 18 are completed it is advisable to bake the armature for an hour. It is to be borne in mind that absolute cleanliness is an essential to good armature winding. It should never be attempted in a machine shop or where there are filings, etc., and dust in the air, but should always be done in a clean, airy place. The wires may be forced straight in the slots with a hard-wood wedge, but care must be taken not to injure the insulation. Above all, don't be afraid to use the shellac.

The soldering of the wires into the commutator should be done with rosin, not acid, as a flux, and any globules of solder that fall on the butt of the commutator must be brushed out. It is well to put a piece of asbestos paper over the head of the armature next the commutator before beginning to solder in the connections.

4. The Alternator Armature: This is much simpler than the direct current armature. The winding consists of 12 coils, exactly alike, made in a former and slipped over the poles. Two of them are shown in position in Fig. 2.

The former for winding these coils is made of three pieces of wood and is shown in Fig. 12. It will save time to make two or three of them. A piece of strong, thin paper is laid in the groove of the former (to prevent the coil sticking to the wood) and shellaced lightly on its inner surface, that is, where the wires are to lay. On this the coil is wound, 98 turns of No. 18 B. & S. gauge double cotton covered wire, 14 turns to a layer, 7 layers. Thick shellac should be applied to each layer. As each coil is finished loosely twist the ends together and put the former carrying the coil into the oven to bake. By having several formers it is possible to bake several coils at once and thus save time. After baking take the former apart and remove the coil. Tear off the loose edges of the paper and tape the coil neatly with ½-in. white silk ribbon, or cotton tape, well shellaced. The inner end of each coil should be marked when it is wound, and all should be wound in exactly the same way.

In putting the coils on the teeth of the armature care must be taken to see that all are put on in the same way, otherwise confusion is sure to result. Then connect the inner end of coil 1 to the inner end of coil 2; the outer end of 2 to the outer end of 3; the inner end of 3 to the inner end of 4; the outer of 4 to the outer of 5; and so on all around the armature, finally connecting the outer end of 12 to the outer end of 1. Any coil may be chosen as the first in this series. If the connections are properly made a direct current sent through all the coils in series before the last connections is made will magnetize the armature teeth alternately north and south. The coils are held in place by small L-shaped pieces of sheet brass screwed to the armature end-plate, as shown in Fig. 2.

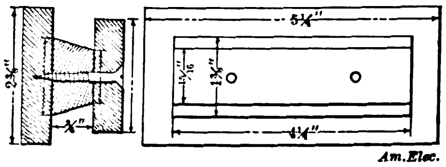


FIG. 12.—FORMER, CROSS SECTION AND PLAN, TOP REMOVED.

Leads should be taken off from the connections between coils 1 and 2, 4 and 5, 5 and 6, 7 and 8, 9 and 10, and 10 and 11, and brought to the binding posts, as indicated in Fig. 11. Running at 1200 r.p.m. the machine, either driven by the direct current motor end or by outside power, will give 110 volts, single-phase, from terminals 1 and 2; two-phase currents, 110 volts on each side, from terminals 1 and 2, and 4 and 5; and three-phase currents, 95 volts on each side of the triangle, from terminals 1, 3 and 6.

The lamp shown is used as an external resistance in the alternator field, it being impossible to put on enough wire of a reasonable size in the limited winding space of the rotating field to secure the needed resistance. It is a 50-volt, 3½-watt 16-c.p.

lamp, or may be of a higher resistance, this depending, as the performance of the machine in most respects will, upon the quality of the cast iron of the two fields and the width of the air gaps. For this reason it is not possible to predict very exactly the performance of the machine, except to say that efficiency has not been especially considered in its design.

Current in D. C. armature, about	8.8 amperes
Current in D. C. field	1 ampere
Current in alternator field (50 volt lamp in circ.)	1 ampere
Total direct current input, about	1,188 watts
Current delivered by alternator armature, about	6 amperes
Volts at alternator terminals, single-phase	110
Total output	660 watts
Efficiency at full load, about	55 per cent.
Speed	1,200 r.p.m
Frequency	7,200 cycles per min.

The above table gives the constants of the machine approximately, assuming it to run as a motor dynamo transforming from direct current at 110 volts to single-phase alternating current at same pressure.

AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

THE EXPRESS SYSTEM.

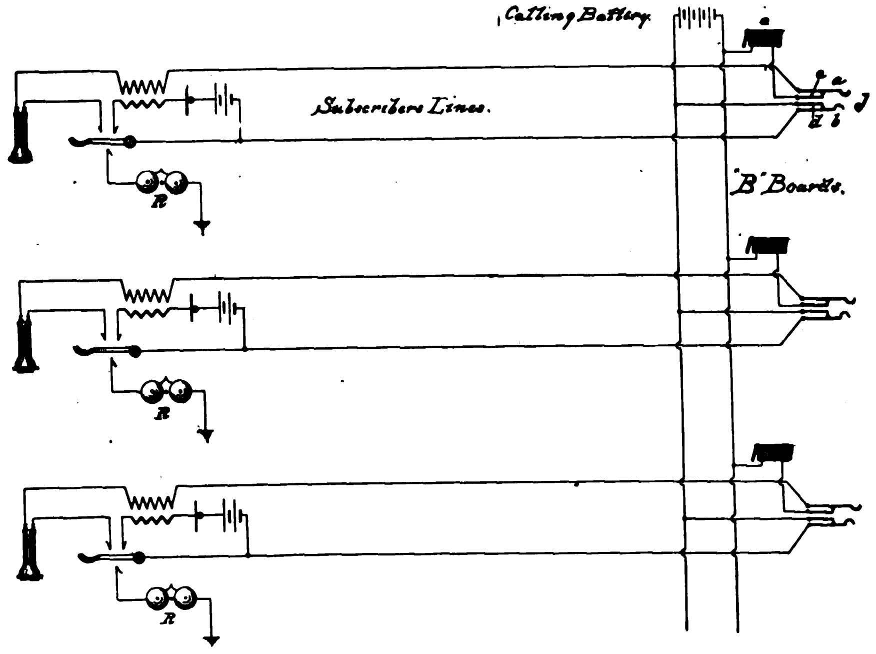
So far the only systems described in this series for handling large exchanges have been those of the multiple type; that is, systems, wherein each line runs through a spring jack on every section of the board in the entire exchange. While one form or another of this general type of board is used in nearly all of the large exchanges in this country, and in fact the world over, there are notable exceptions, and the success of some of these, coupled with the inherent difficulties due to the very nature of the multiple board, leads me to believe that the coming system, while it may in some degree embody the plan of the multiple jacks, will depend for its action on other ideas already developed to a very considerable extent.

In the multiple switch board the cost of installation increases approximately as the square of the number of the subscribers. When a new section containing, say, 200 spring jacks, annunciators and other apparatus is added to an exchange, the increase does not end there. Two hundred multiple jacks must be added also to each of the sections already existing in the exchange. This is clearly an objection, which increases in seriousness as the exchange grows. A multiple board having a capacity for 6000 lines would probably be divided into 30 sections of 200 lines each. On each section would be placed the 6000 multiple jacks, plus the 200 answering jacks belonging to the particular 200 lines whose annunciators were located at that section. This would make a total of 6200 spring jacks on each section, or 186,000 in all. The first cost is, therefore, large, increasing the board is excessively expensive, and cost of maintenance is necessarily heavy.

When, in addition to these facts, it is considered that each jack may be the cause of an open circuit, or a short circuit, which is worse, and that other electrical difficulties pointed out in previous articles also exist, it will be evident that the multiple board is not the perfect system. It has met certain requirements with a fair degree of success, better perhaps than any other known system has shown its capability of doing; but with such grave defects, the existence of which are due solely to the very nature of the system, are we to suppose that the multiple board can survive long in this age of constant improvement?

The enormous multiplying of jacks in the multiple system is for one purpose—to enable each operator to have within her reach a terminal of every line in the exchange, to the end that she may be able herself to complete any connection called for over any one of the lines under her immediate supervision. That is, that she may be able to answer any call arising at her section, and, without requiring the aid of any other operator, make the connection called for. In other words, in a 6000 exchange, 186,000 spring jacks would be used, instead of only 6,000, in order to accomplish this result.

Clearly, if multiple jacks are not used, two operators or more will have to be instrumental in making a connection between two subscribers whose lines terminate on different portions of the board. It would seem at first thought that this would be a considerable disadvantage, and would result in a slower system. On further consideration, however, why should it be more of a disadvantage to divide the labor of manipulating a switchboard between several operators, than it is to apportion the labor of making a pair of shoes or any other manufactured article among a large number of operators, as is now done in all large factories?



SUBSCRIBERS' CIRCUITS, EXPRESS SYSTEM.

The loss of time required by one operator having to repeat an order to another, or, as is the case in some systems, of the subscriber having to repeat his own order, is or should be fully compensated for by the gain in simplicity over the multiple system.

One of the most successful efforts to do away with the multiple jack system is that embodied in the express system, due to Messrs. Sabin & Hampton of San Francisco. This system has been used for several years in San Francisco, and has demonstrated its capability of handling with success an exchange having over 6000 subscribers.

The system is so radically different from anything so far described that its consideration in detail should be a matter of much interest. One striking feature in it is that no magneto generators are used at the subscriber's station, and when it is considered that approximately one-third of the cost of a complete telephone set of the ordinary type is in the magneto, it will be seen that this is a saving of considerable moment. The doing away of the magneto, however, is not an essential feature of the express system, but is one of the advantages incident to its use.

Briefly stated, the underlying ideas of the express system are as follows: The boards are divded into two classes, termed for convenience "A" and "B." Similarly, the operators at the respective boards are termed "A" operators and "B" operators. There is but one line jack for each line in the exchange, and these are divided into groups of one hundred each and are placed only at the "B" board. At the "A" boards, which are entirely removed from the "B" boards (they may even be in another exchange), are placed plugs which form the terminals of other trunk lines leading *from* the various "B" boards; and also jacks forming the terminals of other trunk lines leading *to* the "B" boards.

The former trunk lines—that is, those terminating in plugs at the "A" boards—also terminate in plugs at the "B" boards. These are termed "A" trunk lines. The latter trunks—that is, those terminating in in jacks on the "A" boards—terminate in plugs on the "B" boards, and are termed "B" trunk lines. When a call is received it attracts the attention of one of the "B" operators by displaying an annunciator in an ordinary manner. The "B" operator at whose board the call is received pays no further attention to it than to insert one of the plugs of an "A" trunk into the jack of that line, thus transferring the call to an "A" operator, who answers it with a listening key in the ordinary manner. No means whatever are provided for a "B" operator to listen in on a subscriber's circuit, this duty being confined solely to the "A" operators.

The "A" operator having learned that the subscriber calling desires to be connected with a certain other subscriber, conveys this information, by means of a special order wire, to the "B" operator at whose board the called-for subscriber's line terminates. The "B" operator then tells the "A" operator what "B" trunk line to use and the "A" operator then inserts the plug of the "A" trunk line used into the jack of the "B" trunk line thus designated. This brings the connection as far as the board of the second "B" operator; that is, the "B" operator at whose board the called-for subscriber's line terminates. This operator, in order to complete the connection, simply inserts the plug of the "B" trunk used into the jack of the called-for subscriber's line, and presses a ringing key in order to call that subscriber.

It will be seen that the connection has really been handled by three different operators, but that the first of these operators do no more than to insert a plug into a jack, giving the matter no further attention.

All signaling between the subscribers and the operators and between the various operators, whether it be for establishing or clearing out a connection, is entirely automatic, and therefore not dependent upon the volition of the parties concerned.

The accompanying figure shows the arrangement of the circuits at the subscriber's stations, and also the arrangement of spring jacks and annunciators on the "B" boards. One side of the line wire at the subscriber's station is normally grounded through the polarized ringer R. This means that calling a subscriber from the central office must be accomplished over one limb of the line wire and ground, instead of over a metallic circuit, as in case of talking and other signaling in this system. The other circuits and apparatus at the subscriber's station are of the ordinary arrangement and type, the only difference being that the magneto generator is omitted entirely. The line wires of each subscriber terminate in two springs, a and b of their spring jack J. These springs normally rest on two anvils, c and d, one of which connects through an annunciator, e, with a heavy wire leading to one pole of the calling battery, and the other of which leads to a similar wire connecting with the other pole of this battery.

This annunciator, e, has a shutter which is simply lifted by the attraction of the armature, and again dropped into its normal position when the armature is released. It is, therefore, the simplest type of self-restoring drop. The circuit of the call battery is normally open only at the subscriber's station. It is automatically closed through the receiver and secondary winding of the induction coil at the subscriber's station whenever the subscriber removes his receiver from its hook. This allows enough current from the calling battery to pass through the drop, e, to raise its shutter, and thus attract the attention of the "B" operator at that board.

The shutter remains raised until the operator inserts the plug of one of the "A" trunk lines in order to transfer the call to the "A" operator. The insertion of this plug, however, lifts the springs a and b from their anvils c and d, thus cutting off the battery and allowing the shutter of the annunciator, e, to drop to its normal position, and the "B" operator therefore pays no more attention to it.

The advantages of this part of the system are numerous. It is simplicity itself. A single battery is made to serve for actuating the signals of every line in the exchange, no matter how great their number may be. Storage batteries are used for this purpose, ten cells being connected in series so as to give a pressure of about twenty volts. It is said that the average flow of current from this battery is about one and one-half amperes, and never exceeds two amperes in the San Francisco exchange of approximately 6000 subscribers. It will be thus seen that the cost of maintenance of these batteries is very trifling.

Another good feature of this arrangement is that, should a "B" operator by mistake withdraw a plug from a jack before a subscriber has finished talking—that is, before he has hung up his receiver—she will be at once notified of her mistake by the display of the signal belonging to that line.

The other circuits and parts of apparatus relating to the trunking signaling between the operators will be considered at length in the next article of this series.

* * *

CENTRAL STATION WORKING.

THE CARE AND TESTING OF ALTERNATING CURRENT RECORDING METERS.

BY R. H. STERLING.

The recording meters of an electric lighting company may be compared to the weighing scales of any mercantile business, for they measure the amount of electric energy used by a customer, and should, therefore, be accurate and reliable, and are, in no small measure, a factor in the dividends of the company.

The meter once installed on a consumer's premises is apt to be a case of "out of sight, out of mind," and is too often left to care for itself year in and year out, and during that time acquiring all manner of friction losses, which, in a large number of meters, amounts to many dollars that should have gone to the company's earnings.

It is proposed in this article to take up the recording ampere-hour meter for alternating current, which is probably more extensively used than the recording watt meter, and we will deal with the Shallenberger type, it being the most familiar and the oldest in use. This class of instrument being less complicated and delicate than the wattmeter, is for this reason unfortunately often considered not to require much care and attention, but it will amply repay all the good treatment shown it.

These meters are frequently taken from the packing boxes, when received from the factory, and placed in position for immediate duty without first ascertaining, by tests, whether they have been altered in their adjustment in transit. A very important reason why meters of this type, having the retarding air veins, should be tested on receipt from the factory, is that in higher altitudes than that where they are manufactured and standardized, they will record considerably faster. This is owing to the lighter air of high altitudes having less retarding effect on the aluminum vanes. In altitudes of 5000 ft. above sea level an increase of 10 per cent will be found over the adjustment of sea level.

The selection of the size of a meter for a given installation deserves careful consideration, owing to the fact that the light-load accuracy is not as great as half and full load, and the failure of the large units to start at all on very light loads.

This question of size is more especially important in residence lighting, for a house may be wired for thirty lights, but in practice not more than five or ten lights will be burning at any one time, except it may be on the occasion of an entertainment, and then not more than twenty turned on. A 10-amp. meter is large enough for an installation of this size. It would carry the overload all right, but would cause some slight drop with this number burning.

The most serious loss with large meters installed in dwellings and even stores, is when a night light is kept burning, for it is seldom that a meter of 40 amps. capacity and over will move on one lamp, more especially if it has been up for any length of time and has accumulated dust and grit, or the jewel has become worn.

Take the case of one night light left burning after 10 P. M. till daylight, or an average of eight hours per night for 365 days, and at 1 cent per ampere-hour, this would mean a loss of revenue of $29.50 per annum. In cases like this it will pay, oftentimes, to put in a separate wiring for night lights and a small meter, or divide the lights into two sections, with a smaller sized meter on each, to prevent such loss.

Now, the question as to how often a meter should be taken down, overhauled and adjusted, depends a great deal on circumstances. The location the meter has been placed in is an important factor, for as their cases are not airtight, and consequently not dust or vapor proof, if placed in a position where much dust can be blown into the cases, a year's time will cause signs of friction to appear. A meter placed in the kitchen of a restaurant will in a short time have its mechanism so clogged with grease, seemingly deposited on it from the atmosphere, that it becomes sluggish. Meters placed in bathrooms or laundries have their steel pivots rusted in a short time, this also causing retardation. A meter set up where it is subject to much vibration and jar should be under suspicion.

Meters brought in for inspection, if gone through in a systematic manner, about to be described, can be cleaned, repaired,

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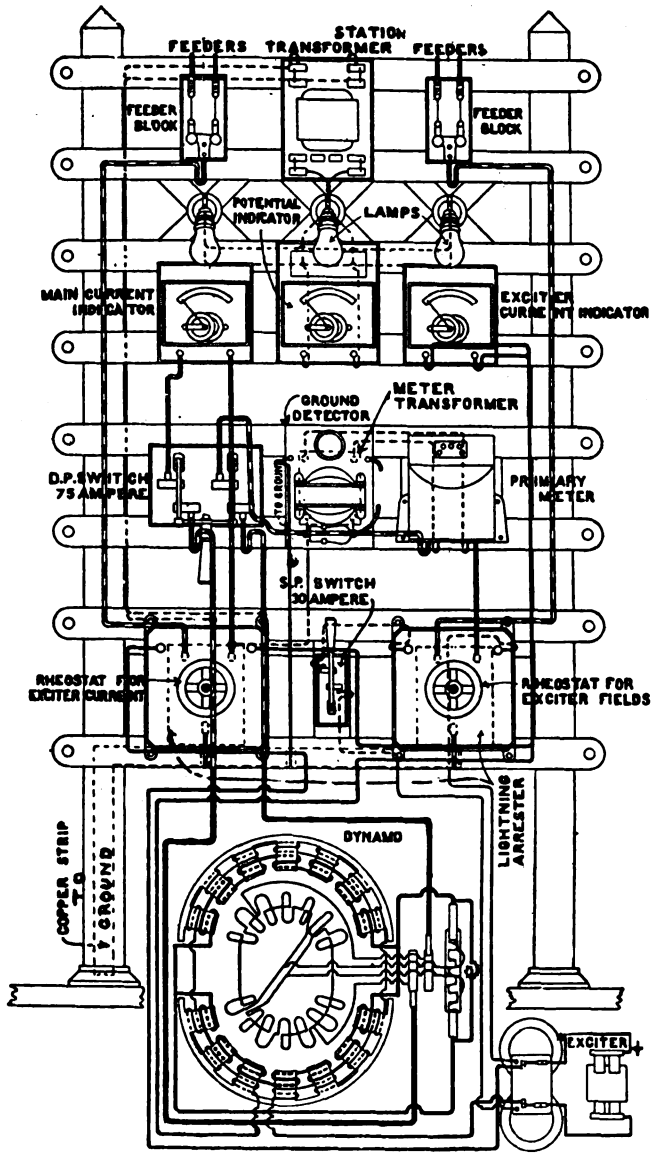
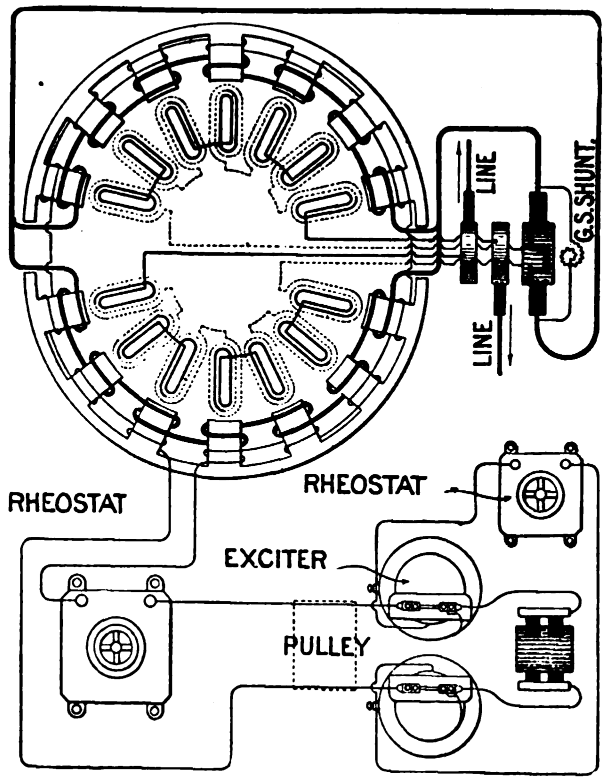
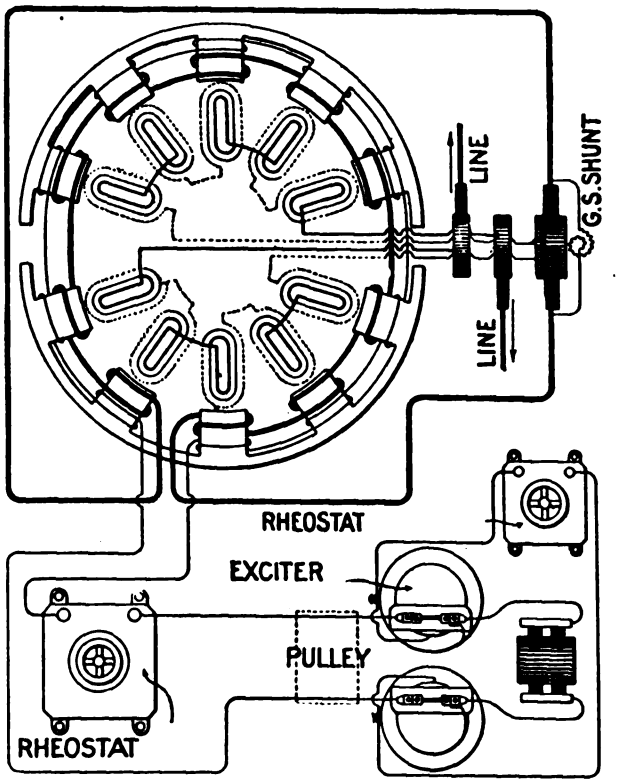
COMPOUND SINGLE-PHASE ALTERNATORS.


STATION TRANSFORMER
FEEDERS
FEEDERS
FEEDER BLOCK
FEEDER BLOCK
POTENTIAL INDICATOR
LAMPS
MAIN CURRENT INDICATOR
EXCITER CURRENT INDICATOR
GROUND DETECTOR
METER TRANSFORMER
D.P. SWITCH 75 AMPERE
TO GROUND
PRIMARY METER
S.P. SWITCH 30 AMPERE
RHEOSTAT FOR EXCITER CURRENT
RHEOSTAT FOR EXCITER FIELDS
LIGHTNING ARRESTER
DYNAMO
COPPER STRIP TO GROUND
EXCITER

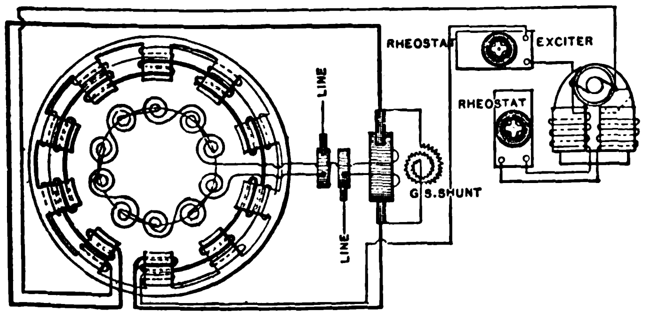
Multiple Armature Coils, Series Compounding Coils. Single-Phase Switchboard.


LINE
G.S.SHUNT
LINE
RHEOSTAT
RHEOSTAT
EXCITER
PULLEY

Compounding Coils in Multiple.


LINE
G.S.SHUNT
LINE
RHEOSTAT
EXCITER
PULLEY
RHEOSTAT

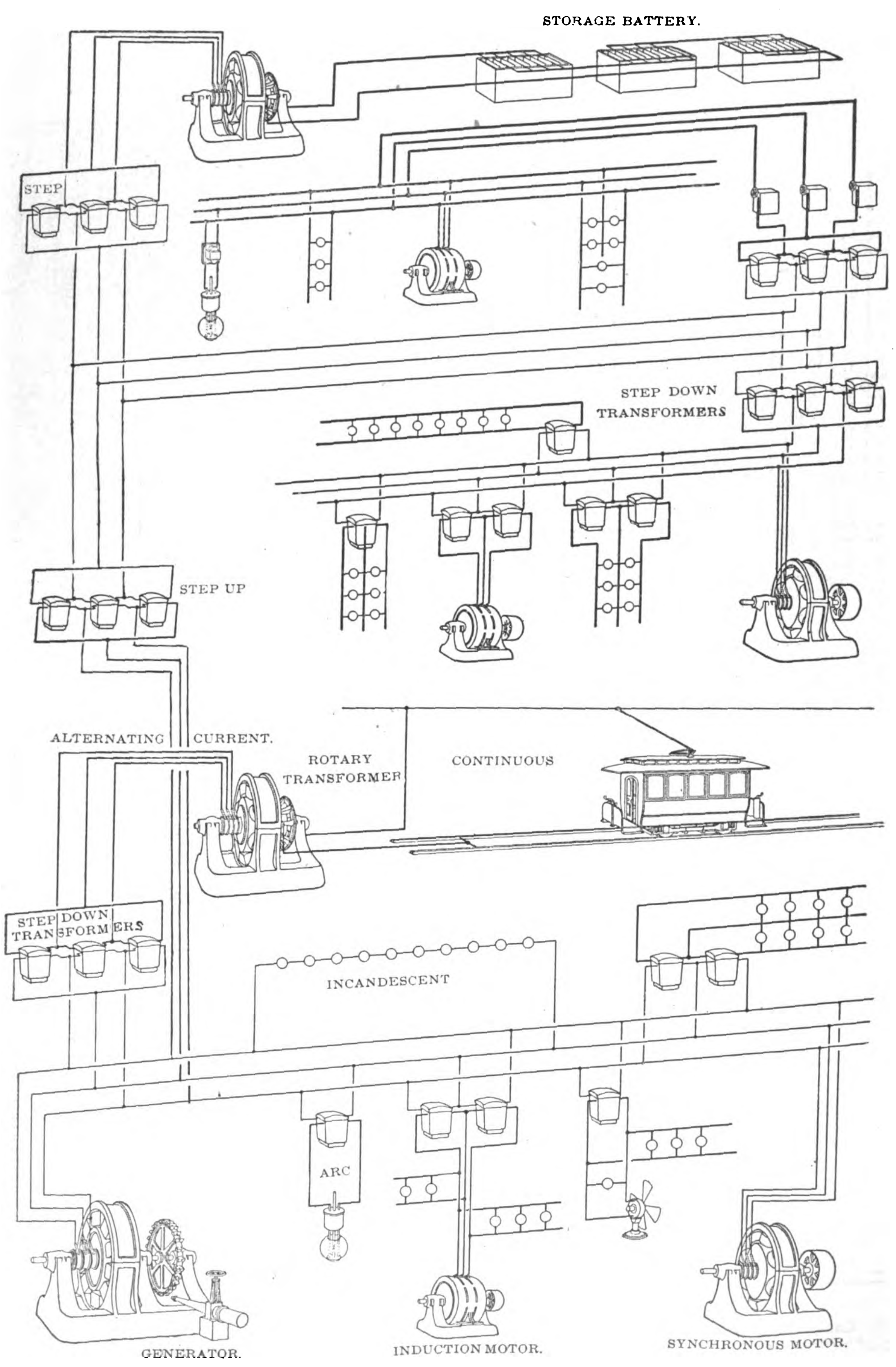
Compounding Coils in Series.


RHEOSTAT
EXCITER
LINE
RHEOSTAT
G.S.SHUNT
LINE

Compound Coil, Exterior Connection.

LIBRARY

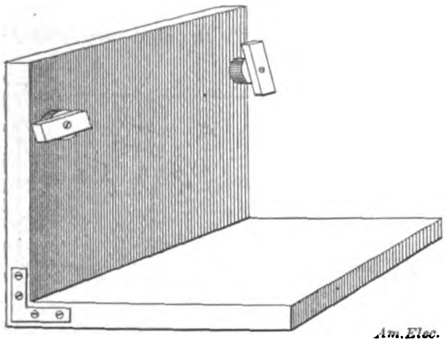
THREE-PHASE TRANSMISSION WITH STEP-UP AND STEP-DOWN TRANSFORMERS.


STORAGE BATTERY.
STEP
STEP DOWN
TRANSFORMERS
STEP UP
ALTERNATING
CURRENT.
ROTARY
TRANSFORMER
CONTINUOUS
STEP DOWN
TRANSFORMERS
INCANDESCENT
ARC
GENERATOR.
INDUCTION MOTOR.
SYNCHRONOUS MOTOR.

tested and standardized in a very short time, and at very little expense; and it will more than repay the care and time given to them in the saving in revenue that will be effected.

The first step is to provide the proper tools and appliances. Procure from a dealer in watchmakers' supplies a pair of long nose pliers, a pair of tweezers, a swivel-top screw driver, a clock hand set (small tool for forcing on dial hands), a bunch of orange wood sticks and a fine-haired watch brush. A low bench facing a good light is the best place to work. A cradle or frame should be provided to hold the meter in an upright position after the case has been removed. The accompanying sketch shows a convenient form, which can be 9 ins. high and about 10 ins. wide, with two turn buttons set out from the back to engage in the ends of the wooden cleat on the back of the meter frame.

Now proceed as follows: With a small hand bellows blow out all the dust from around the movements; then remove the three brass screws holding the decimal train to the frame, and take off the cap that closes the oil cup on top of the meter shaft, and place the whole set of gears in a large-mouth jar, half filled with gasoline; a Le Clanché battery jar, with a wooden cover, answers this purpose well.



CRADLE FOR HOLDING METER FRAMES.

While the gears are soaking in the gasoline to remove all grease and dirt, the rest of the meter is gone over. First, loosen the set-screw holding the vane on the shaft, and slide the vane up as far as it will go, letting two of the wings go in between the two field coils; now, with a small wrench remove the cap of the jewel and with the point of a fine needle passed over the surface of the jewel, feel for any roughness. If the slightest trace of unevenness is felt, the jewel has become worn, and a new one must be inserted in its place, taking care first before removing the old one, to measure its height from the arm holding it, and adjust the new one to the same distance. If the jewel has become much worn, it is best to either renew the shaft or repolish the end of the old shaft in a lathe with fine rouge, for in the wearing of the jewel its roughened surface has worn away the polished surface of the steel shaft, which in its turn would injure a new jewel, if it were not repolished.

The wearing out of jewels in this class of meters is not frequent, owing to the light weight of the shaft and armature revolving on it. If the best sapphire jewels are used, they will have a long lifetime. The old jewels need not be thrown away, but when enough have accumulated they can be repolished by a lapidist. The jewel having been inspected, the vane is now replaced and the wings carefully straightened, and the teeth of the small gear on the top of the shaft cleaned with the brush.

Before removing the train of gears from the bath of gasoline, swash them about a few times to dislodge all traces of foreign matter, and then while inspecting the dial hands, the gasoline will evaporate, leaving everything clean and bright. The dial hands should all be carefully gone over with the set, and with a light tap driven down tightly. Nothing is so annoying as to have a loose hand cause an error in a reading, as it frequently does. Hold the dial on a level with the eyes and see that none of the hands touch the enamel dial; if they do, bend them away with the tweezers. It is a good plan to turn the hands to zero; this will prove the adjustment of them all, and show that none has lost its relative position. The enamel dial should be wiped clean with a soft cloth, as well as both sides of the glass face.

In placing the train back on the frame, the tweezers will be found convenient in pointing the end of shaft back into its bearing, which bearing should first be reamed out with the sharp pointed end of a piece of orange wood. With everything in position once more, start the shaft revolving by blowing on the vane, and notice if there is any wabble in the armature, or scraping of the wings against the frame or fields. The armature should run perfectly true.

The question of oil now comes up. It was once considered essential to have oil on the moving parts of a meter, especially on the jewel. If the oil is used at all, none but the best quality of watch oil is permissible, and that only in the smallest quantities. It is better to err in having too little than too much. A small pointed brass wire, dipped in oil and shaken, carries sufficient oil to go over the whole meter by touching each part lightly. It is found best to use no oil on a well-polished jewel and pivot.

The meter is now ready for testing, but a preliminary test should be given it to ascertain its starting qualities on a light load, or to see to what degree friction has been eliminated by the cleaning just given it. A meter case should be provided with a glass face inserted opposite the veins, so that their motion can be seen, for air currents would otherwise disturb the test if made without the case.

Now have a bank of lamps containing three or four 16-c.p. 50-volt lamps; one 8-c.p. 50-volt, and one 8-c.p. 100-volt lamp. Five and ten ampere meters should start on the 8-c.p. 100-volt lamp; 20 amps. with the 8-c.p. 50-volt, and a 40-amp. on two 16-c.p. lamps, but occasionally one of this size will start on one lamp; an 80-ampere meter requires from three to four lamps to start it. If a meter fails to start on the lamps mentioned, there is some binding or friction taking place, and it should again be gone over. Frequently a meter has to be entirely taken apart and each pivot hole reamed out with the orange wood, and the gear wheels thoroughly polished with the brush, and pivots polished, before it will start on the proper load here prescribed. This is usually the case with meters that have been in a moist atmosphere and have become oxidized badly.

There are several methods of testing a meter for accuracy. The most common method is to have standard meters of each size, and to place twenty or thirty in series with a standard meter of the same capacity, and let 100 ampere-hours pass through them and compare at the end of the run their registration with the standard meter; then those that have proved too fast or too slow are adjusted by turning the movable coil slightly to the right or left—toward the right hand lessens the speed of rotation, to the left increases the speed. Those meters that do not come within 1 per cent of the standard should be run through a second time. The advantage of this method of testing is that after a day's work of cleaning and repairing a lot of meters, they can be left to themselves in the testing rack to run through the night and be ready in the morning to note the result; and where stations do not have a day service it does not require the long hours of night work necessary with the stop watch method, which will be described in following article.

◆

NAVAL MARINE ELECTRIC LIGHTING.

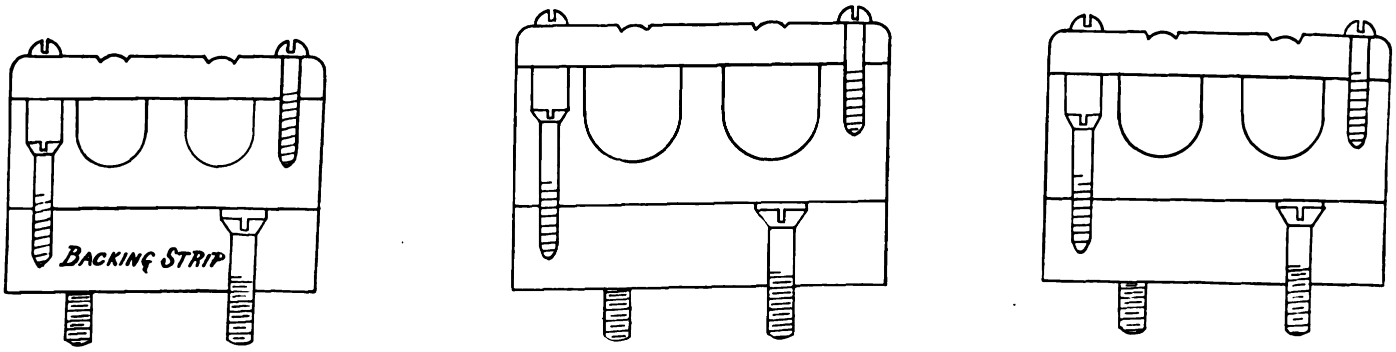
BY E. W. COUNTISS.

It is hard to conceive of a situation where an installation of electric light and bell work is put to such a severe test in actual everyday service as on one of our modern naval vessels. On the bridges and decks there is not only the inclemency of the weather to contend with and guard against, but also the seas that break over the vessel in heavy weather. In the fire and engine rooms there is the heat from the boilers and engines, as well as the moisture from sweating and escaping steam. To stand for any length of time the work must be done thoroughly, both electrically and mechanically, using none other than the best material.

Specifications covering the work in the electrical equipment of U. S. naval vessels are exceedingly complete, covering almost every conceivable point that may be raised, from the construction of the foundations of the generating sets to the size of the screws that secure the lids to the junction boxes.

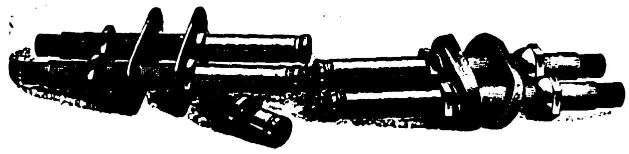
By consulting the illustrations accompanying this article, it will be seen, without detailed description, that the various accessories meet the requirements very fully. The details will be mentioned as we have occasion to use them during the progress of installation, and without quoting the specifications too frequently, we will give the "kernel" by adhering to their requirements.

There are two divisions of the circuits called "Lighting" and "Motor" circuits.

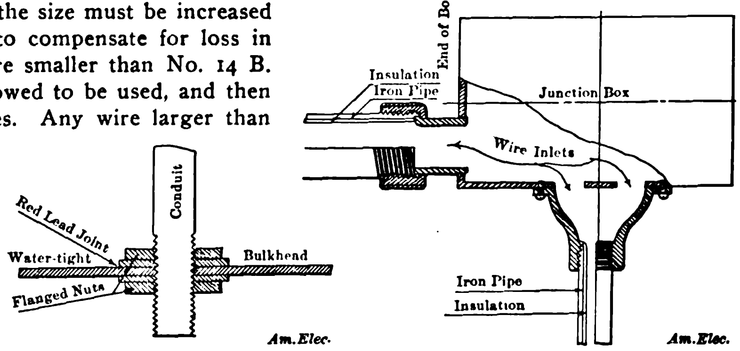


FIGS. 1, 2 AND 3.—MOLDINGS.

The lighting circuits are again divided into six divisions, according to the services required, namely, "Continual," "Battle," "General," "Sea," "Day," and "Special" services. While the divisions are so numerous, a number of them are but submains branching from the trunk lines, which start from the switchboard in the dynamo room. Each sub-division is controlled by a double pole switch of ample capacity, placed in a convenient location. For instance, the lights on the circuit for sea service are taken off the mains for continual service; the lights for day service are on a sub-main branching off from the mains for general service. The battle service mains have their own feeder and start at the switchboard, and carry current to the lamps lighting the magazines, handling rooms, ammunition hoists, central station, conning tower, and battle lanterns at the guns when in action.



FIGS. 4, 5 AND 6.—MAIN DECK, BULKHEAD AND PROTECTIVE DECK STUFFING TUBES.



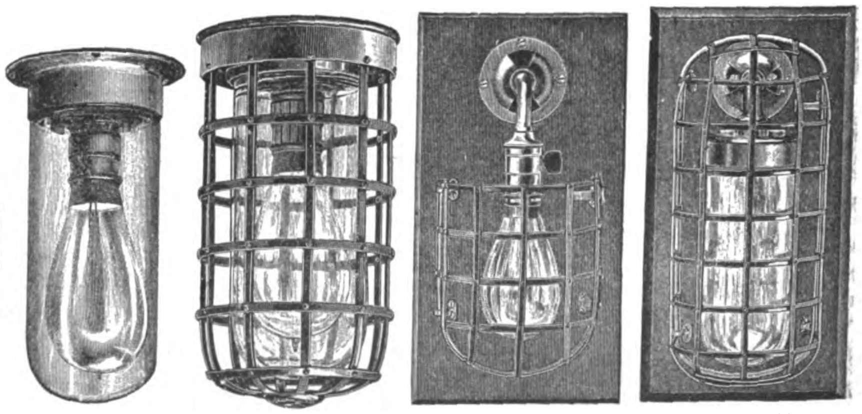
FIGS. 7 AND 8.—IRON-ARMORED CONDUIT AND COUPLINGS.

The signal circuit leads directly from the switchboard, for the lighting of the binnacles, running lights, stay lights, stern lights, truck lights, Ardois signal hoist, and various others for general signal purposes.

The searchlights have their own independent leads, and are not connected to any other circuit.

The number of feeders leading from the switchboard is determined by local conditions and the load they carry. No circuit can carry over 75 amps. The circuits are divided up into decks, starboard and port, or forward and aft, and sometimes it is necessary to use both combinations to keep within the limits allowed or fixed by the construction of the ship. To keep the service intact, wherever possible, the feeders are run below the protective deck, and where occasionally space does not permit this to be done, then as far inboard as practicable. The vertical risers must be protected by such means as can be procured. To further carry out this system, a plan of connecting two feeders together by means of double-pole switches is used, so that in case of accident to one circuit, the neighboring one can be cut in.

FIGS. 9 AND 10.—CEILING FIXTURES.



FIGS. 11, 12 AND 13.—STEAMTIGHT AND BULKHEAD FIXTURES.

The least sectional area allowed is 1000 circular mils per amp., irrespective of length or load; but where the drop is over 3 per cent, then the size must be increased above this rate to compensate for loss in voltage. No wire smaller than No. 14 B. & S. gage is allowed to be used, and then only for branches. Any wire larger than this must be stranded conductor, varying in the number and size of strands according to area. Where feeders are cross-connected, the area per amp. must be at least 1500 circular mils, with the same correction for drop as before mentioned. The only exceptions to the foregoing instances are made in favor of the searchlight feeders, where 500 circular mils per amp. are allowed.

In figuring for size of wire for feeders, let us take a circuit carrying 30 16 c.p. lamps, taking .9 amps. per lamp, this being according to specifications, and corresponding therefore to 27 amps. Allowing 1000 circular mils per amp., the least size wire allowable is 27,000 circular mils. Suppose the distance in wire-feet from switchboard to feeding center is 500, then the drop at 80 volts (which is the voltage used), would be 5.5 volts, or nearly 7 per cent. A wire of at least 61,875 circular mils would be required to keep within the 3 per cent allowed; but the nearest size according to standard is 60,088 circular mils, and as this is yet too small, the wire to be used would be the next larger size, or 75,776 circular mils, which would have 37 strands of No. 17 B. & S. gage. The figures are approximate only, to illustrate the manner of determining the size wire to be used. Each circuit must necessarily be determined alone after the number of lights is decided upon for that circuit.

Having found the size of the wire, it determines the size of the molding (Figs. 1, 2 and 3), conduit and hard rubber bushings. Each size of wire has the diameter over braid, etc., specified. By reference we find the size of the bushing must be 13-16 in. inside diameter and 1 1-16 in. external diameter, which must have a hole 1⅛ in. diameter drilled to receive it. The molding must be 3⅛ ins. wide, with gutter ¾ in. wide and deep. Or, if we use iron-armored conduit, it must be 1 in. bore. Where we go through iron or steel bulkheads that separate the water-tight compartments from each other, we must drill and tap the bulkhead for the stuffing tube (Fig. 5), and pass from one compartment to the other through this tube, making it secure by means of a soft rubber bushing and stuffing nut. Where the wire passes through the decks, a plain deck stuffing tube is used (Fig. 4), or if on an inclined surface the protective deck tube (Fig. 6) is used in the same manner. Cuts of the several various sizes and styles of moldings are shown in Figs. 1, 2 and 3.

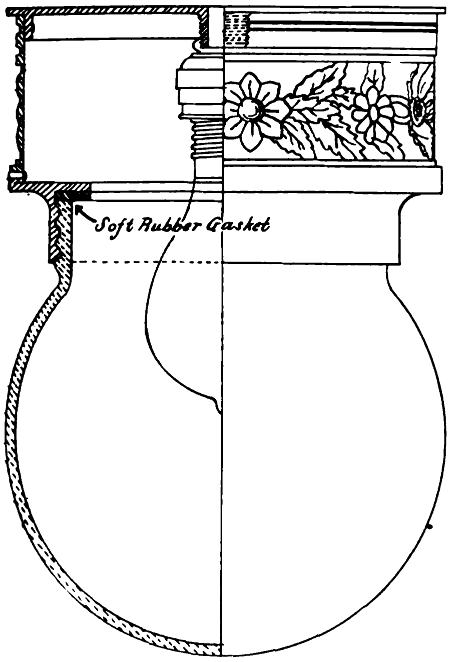
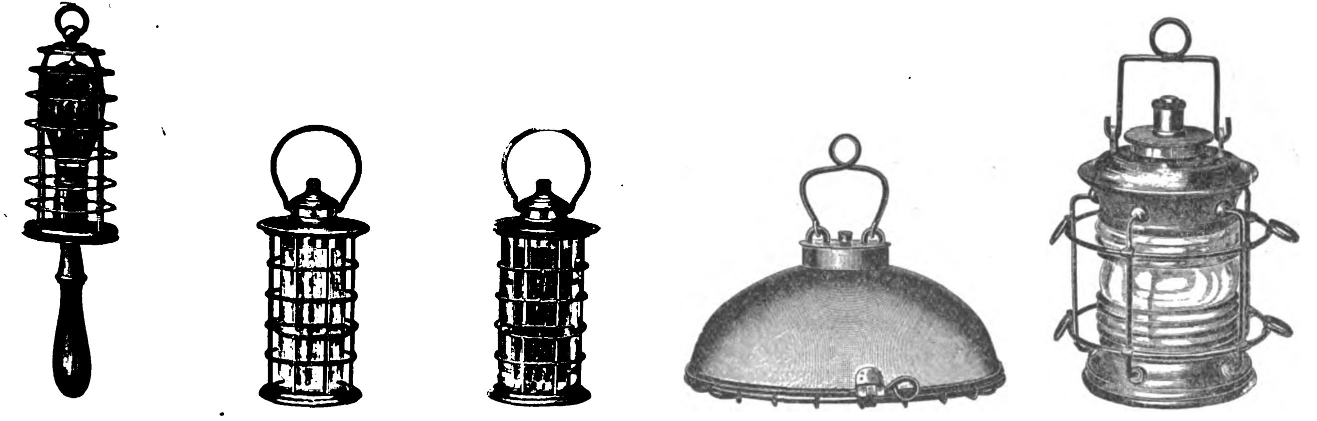


FIG. 14.—CEILING FIXTURE.

Taking for granted that the different styles of fixtures have been selected, and their location determined upon, the route the mains, branches and feeders must take now demands attention. The line must be as straight as possible, and clear of bolts, nuts and rivets of unusual size; small detours are allowed to avoid these and other obstructions.



FIGS. 15, 16, 17, 18 AND 19.—PORTABLE LAMPS.

The wires are carried in molding or conduit. If molding is used it must be of the same wood as the surrounding joiner work, which generally is white pine painted. But if the bulkhead is finished in hardwood, the molding must correspond with it. A backing strip is laid in advance of the molding over metal surfaces, and secured in place by No. 14 flat-head brass machine screws, with 20 threads to the inch. They must be placed not over 12 ins. apart and staggered, being countersunk below the level. All molding and backing, except hard wood, must be thoroughly painted after being fitted and before being secured in place. Molding is to be used in the cabins, state rooms and officers' quarters generally. But in the water-tight compartments and on the spar deck, and under bridges and all exposed places, iron armored conduit must be used. The method used is fully shown in Figs. 7 and 8.

Let us next turn our attention to the different styles of fixtures used before we attempt to locate them. The ceiling fixtures shown in Figs. 9, 10 and 14 are installed in the cabins and ward rooms, in place of electroliers, which are no longer used. The ceiling fixture of Fig. 10, as well as the steam tight globe (Fig. 11), is used for general overhead lighting, the steam-tight fixtures being protected with a wire guard (Fig. 12), where liable to be broken.

The bulkhead lights (Fig. 13) are used for standing lights in all places except offices and officers' quarters. Where the steam-tight globe is too long on account of the guard, and a guarded fixture is necessary, the bulkhead fixture may be used. Where hammocks are swung the bulkhead fixtures are lowered until the top of the fixture block is about 3 ft. above the deck. This then dispels the shadows caused by the hammocks, and the lamps are in use all night, whereas the overhead lights are all turned off at 2 bells or 9 P. M.

The bunker-lights (Fig. 20) are to light up the coal bunkers. Portables (Fig. 15), decks (Fig. 16) and battle lanterns (Fig. 17), and cargo reflectors (Fig. 18), are used where standing or stationary lights would be almost useless, and are provided for general uses when a shifting light is needed. The battle lantern has a shield which can be rotated until the rays of light can be entirely cut off, and thus form a dark lantern. Racks with hooks are provided for the stowage of these close to where they will be needed. The signal lanterns (Fig. 19) are provided in three colors—red, white and green, and are used for various signaling purposes. One and two light brackets are used over sideboards and transom sofas, where other fixtures would be in the way. As the ceiling fixtures are quite flat, the greater part of the light is lost except directly under the fixtures, particularly when the beams are wide. In the latter case a block about 4 ins. thick is secured overhead, and the fixture screwed to it. This brings the lamp below the level of the beams and gives a greater illumination.

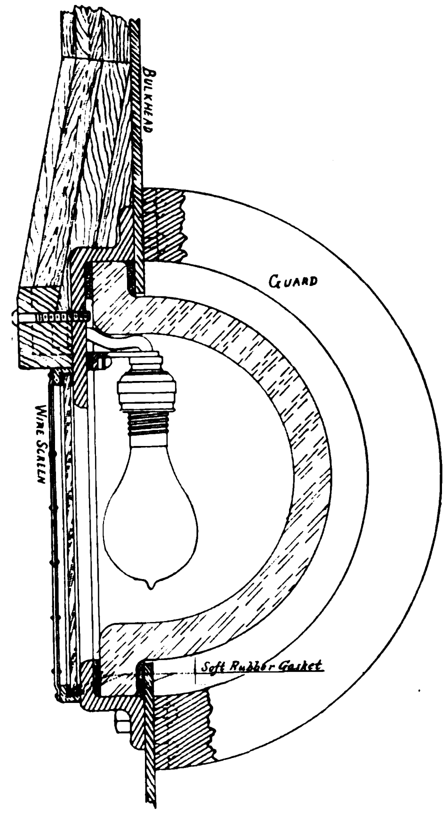


FIG. 20.—COAL BUNKER FIXTURE.

In a succeeding article the arrangement of other lights, the dynamo-room, searchlights, signals, etc., will be taken up.

INTERIOR WIRING.

BY CHARLES E. KNOX.

BRANCH CIRCUIT WORK.

Let us now select points for locating the cut-out groups or distributing centers. Up to this time we have considered the location of these centers solely with reference to architectural requirements, but now we must consider them in conjunction with the branch circuit work.

It frequently happens that after running the branch circuits on the plans, we find, in certain cases where these groups were located, that their positions may be changed to advantage, or sometimes certain groups may be dispensed with entirely and the circuits run to other points. We now see the wisdom of ascertaining from the architect where cut-out groups may be located, rather than selecting particular points for their location.

Having in view, then, the relation of these centers of distribution to the branch circuit wiring, we must bear in mind the following points when selecting their tentative location:

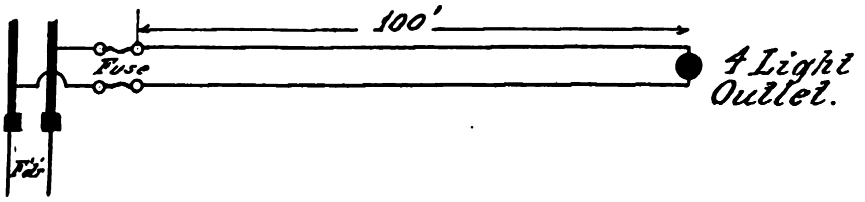


FIG. 1.—BRANCH CIRCUIT WITH GROUP OF LIGHTS.

1. As a rule, wherever possible, it is wise to limit the length of each branch circuit to 100 ft., and the numbers and location of the distributing centers should be determined accordingly.

2. Except in special cases, it is also wise to limit the number of circuits fed through any group of cut-outs to 25 or 30.

In regard to the first point, it may be stated that it is sometimes necessary and even desirable to increase the limit of length. One instance of this may be found in hall or corridor lights in large buildings. It is generally desirable in such cases to control the hall lights from one point, and as the number of lights at each outlet is generally a small number, it would not be economical to run mains for sub-centers of distribution. Hence, in instances of this character the length of runs will frequently exceed the limit named. In the great majority of cases, however, the best results are obtained by limiting the runs to 90 or 100 ft.

There are several good reasons for placing such a limit on the length of a branch circuit. To begin with, assuming that we are going to place a limit on the loss in voltage (drop) from the switchboard to the lamp, it may be easily proven that up to a certain reasonable limit it is more economical to have a larger number of distributing centers and shorter branch circuits than to have fewer centers and longer circuits. It is usual, in the better class of work, to limit the loss in voltage in any branch circuit to one volt. Assuming this limit (one volt less), it can readily be calculated that the number of lights at one outlet that may be connected on a branch circuit (using No. 14 B. & S. wire) 100 ft. long is four lights (see Fig. 1); or in the case of outlets having a single light each, five outlets may be connected on the circuit, the first being 60 ft. from the cut-out, the others being 10 ft. apart (see Fig. 2).

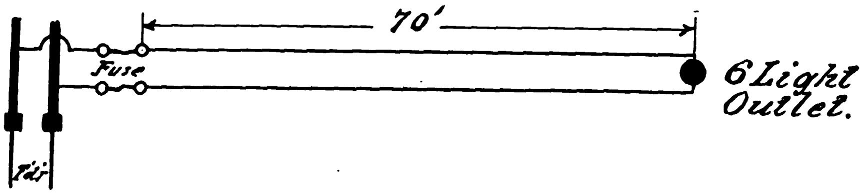


FIG. 3.—BRANCH CIRCUIT WITH GROUP OF LIGHTS.

These examples are selected simply to show that if the branch circuits are much longer than 100 ft. the loss must be increased to more than one volt, or else the number of lights that may be connected to one circuit must be reduced to a very small quantity, provided, of course, the size of the wire remains the same.

Either of these alternatives is objectionable, the first on the score of regulation, and the second from an economical standpoint. For if, for instance, the loss in a branch circuit with all the lights turned on is four volts (assuming an extreme case), the voltage at which a lamp on that circuit burns will vary almost four volts, depending on the number of lights burning at the time. This, of course, will cause the lamp to burn below c.p. when all the lamps are turned on, or else to diminish its life by burning above the proper voltage when it is the only lamp burning on the circuit. Then, too, if the drop in the branch circuits is increased, the sizes of the feeders and mains must be correspondingly increased (if the total loss remains the same), thereby increasing their cost.

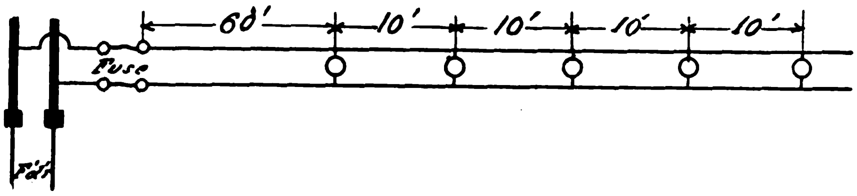


FIG. 2.—BRANCH CIRCUIT WITH DISTRIBUTED LIGHTS.

If the number of lights on the circuit is decreased we do not use to good advantage the available carrying capacity of the wire.

Of course, one solution of the problem would be to increase the size of the wire for the branch circuits, thus reducing the drop. Whatever slight saving this might cause (if any at all) is entirely offset by the fact that the number of amperes which may be fed through a branch circuit fuse is limited to six or eight; in order, therefore, to take advantage of the increased carrying capacity of the wire we must use fixture cut-outs, which, as we said before, is extremely objectionable. The better solution is to increase the number of cut-outs, thus shortening the length of the branch circuits and using No. 14 B. & S. gage wire.

We referred above to calculating the loss in a branch circuit. As this is a problem which continually arises in laying out branch circuits, it may not be out of place at this juncture to explain the method of calculating the "drop" in a branch circuit. Although it is a simple problem it has, nevertheless, frequently proved a very puzzling one.

For the benefit of the more practical reader, to whom mathematical symbols are more or less confusing, we will try to make the problem as simple as possible, and will, therefore, make the consecutive steps as gradual and detailed as may be necessary to gain this end.

We know that the resistance of a wire increases as the length increases and decreases as the size (i. e., the area or cross-section) varies. If we know the length (measured in feet) and the cross-section or area (measured in circular mils) of any piece of wire, we can calculate its resistance, provided we know the resistance of a wire 1 ft. long and 1 mil (i. e., 1-1000 in.) in diameter. The resistance of a "mil foot" (as it is called) of wire has been determined by tests, in the case of copper wire having a conductivity of 98 per cent of pure copper, and when measured at about 68 deg. F. (20 deg. C.) to be equal to 10.56 (international) ohms. (This is based on the copper wire table issued by the American Institute of Electrical Engineers in 1893.) In other words, the resistance of a wire measured in ohms is equal to the length measured in feet divided by the area measured in circular mils, this quotient being multiplied by 10.56, the resistance of one mil-foot; that is,

$$R = \frac{F}{\text{c.m.}} \times 10.56,$$

where R = ohms, F = feet, and c.m. = area in circular mils.

Now, from Ohm's law we know E = CR. Placing in this equation the equivalent value of R in the first equation, we get

$$E = \frac{C \times F \times 10.56}{\text{c.m.}}; \quad (1)$$

or expressed in words, formula (1) means that the difference in voltage ("drop") between any two points of a circuit is equal to the current flowing through that circuit, multiplied by the length (in feet) of the circuit, divided by the area (in circular mils) of the wire, and multiplied by the resistance of one mil-foot of wire.

Now, as the length of a circuit is generally given as the distance measured one way (i. e., one-half of the length of wire constituting the circuit) it would be simpler to substitute this quantity, which we will represent by the letter D, in the formula, F, of course, being equal to twice D; that is,

$$E = \frac{C \times 2 \times D \times 10.56}{c.m.} \quad (2)$$

Now, as we have two constants, namely, 2 and 10.56, it will make the formula simpler if we multiply them together; thus,

$$E = \frac{C \times D \times 21.12}{c.m.} \quad (3)$$

Remember, that D is the distance one way, or the length of one leg of the circuit, and that we still get the resistance of both legs of the circuit in the formula, because this distance is multiplied by the factor, 2, which now forms part of the constant, 21.12.

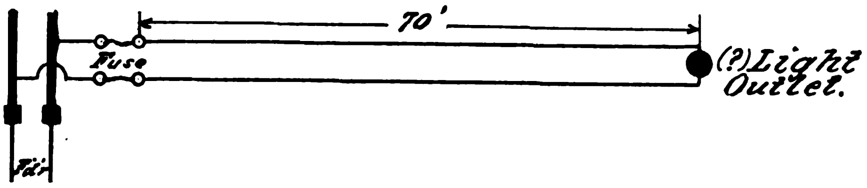


FIG. 4.—BRANCH CIRCUIT WITH GROUP OF LIGHTS.

The formula, as above expressed, is used where the current, A, to be carried the distance, D, and the area of the wire, c.m., are all known, and we wish to determine the loss in voltage in the circuit. If we wish to find the size of wire required where the loss, length of circuit and current carried are given, we can, by transposing the terms, get the formula in this form:

$$c.m. = \frac{C \times D \times 21.12}{E}; \quad (4)$$

or, if we wish to determine the current that may be carried through a certain size of wire, where the distance and loss are fixed, we would use the formula in the following form:

$$C = \frac{c.m. \times E}{D \times 21.12}; \quad (5)$$

in a similar manner, if we wished to determine the length that a circuit might be and produce a given loss with a given current in a fixed size of wire, the formula would be:

$$D = \frac{c.m. \times E}{C \times 21.12} \quad (6)$$

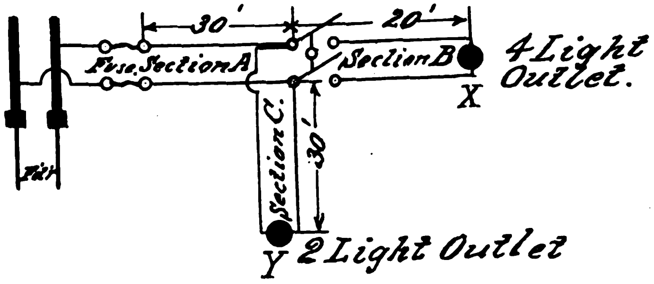


FIG. 6—BRANCH CIRCUIT WITH PARALLEL BRANCHES.

If, however, instead of dealing in amperes, we had lamps to consider in our calculations, it might be simpler (where a number of calculations, involving lamps taking the same quantity of current, were to be made) to substitute a value for lamps in formulas 3, 4, 5 and 6. The current in any case would be equal to the number of lamps multiplied by the current used by each lamp. In the case of a 16-c.p. lamp (using 3.5 watts per c.p.) the current required per lamp, burning at 116 volts, would be .48. Representing the number of lamps by L, formula 3 would become:

$$E = \frac{L \times .48 \times D \times 21.12}{c.m.} \quad (7)$$

To simplify the formula, we will multiply the two constant quantities (.48 and 21.12) together, and (7) becomes:

$$E = \frac{L \times D \times 10.14}{c.m.} \quad (8)$$

In similar manner formulas (4), (5) and (6) become:

$$c.m. = \frac{L \times D \times 10.14}{E} \quad (9)$$

$$L = \frac{c.m. \times E}{D \times 10.14} \quad (10)$$

$$D = \frac{c.m. \times E}{L \times 10.14} \quad (11)$$

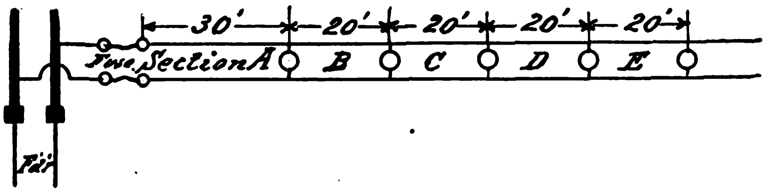


FIG. 5.—BRANCH CIRCUIT WITH DISTRIBUTED LIGHTS.

In a similar manner we could change the formula for lamps, taking any number of amperes or fractions thereof.

We have gone into the derivation of the above formulas with such minute detail as to run the risk of being wearisome, but wiremen who frequently have occasion to calculate the loss in circuits, either do not know the formula, or are so puzzled by terms of the formulas that they are unable to use it intelligently. Then again, many of those who use these formulas continually do not know what the constants signify, nor how they are derived.

Of course, there are tables, charts and slide rules innumerable, but as a rule they are either inaccurate or more difficult to use than the formula. Nearly all of them are good only within certain narrow limits of length, current and drop.

Having derived the formulas, let us now apply some of them. Suppose we have a circuit 70 ft. long, of No. 14 B. & S. wire, supplying a six-light chandelier (see Fig. 3). What is the loss or drop in voltage between the cut-out and the lamp?

Here D (distance) = 70.
L (No. of lamps) = 6.
c.m. (area in circular mils of No. 14 B. & S.) = 4106.

Substituting these values in formula (8) we get:

$$E = \frac{6 \times 70 \times 10.14}{4106} = 1.05 \text{ volts loss.}$$

Suppose we had a circuit 70 ft. long of No. 14 B. & S. gage (see Fig. 4), and we wished to limit the loss to .8 of one volt, how many lamps could we carry on that circuit? We would have by substituting in formula (10):

$$L = \frac{4106 \times .8}{70 \times 10.14} = 4.6, \text{ or } 5 \text{ lamps.}$$

Given a circuit having a number of outlets with one or more lights at each. How would you calculate the loss? It is evident in this case that you cannot take the whole length of the circuit and the total number of lights supplied, for the reason that the different sections of the circuit carry a different quantity of current and consequently the loss in each section will vary according to the quantity of current carried and the length of wire through which it flows.

Let us suppose we have a circuit, the total length of which is 110 ft., and which supplies five outlets having a single light each (see Fig. 5). The distance from the cut-out in this case to the first outlet is 30 ft.; the other outlets are 15 ft. apart. What is the loss to the last outlet?

The way to do this problem is to calculate the loss in each section (see Fig. 5) separately, and then add them together. Thus, taking section A from formula (8) we have, substituting the different values:

$L = 5$
$D = 30.$
$c.m. = 4106.$

$$E = \frac{5 \times 30 \times 10.14}{41.06} = .38$$

That is, the loss in section A, or the loss from the cut-out to the first lamp, is .38. In similar manner we find the loss in the other sections to be:

Section B = .15
" C = .11
" D = .075
" E = .038

.373
Total loss to last outlet = .75

Given a circuit where at a switch or an outlet the circuit divides into two parts, what is the loss in the two branches?

Suppose we have a circuit as shown in Fig. 6. It is evident that you proceed in this case in a manner similar to the last one. Here we take the first section to the point where the circuit divides, in this case in section A, we get:

$$E = \frac{6 \times 30 \times 10.14}{41.06} = .45.$$

In section B we get .2, and in section C we get .15. Now, to get the loss from the cut-out to outlet, X, we add the loss in section A to the loss in section B, which amounts to .65; in similar manner, to get the loss from the cut-out to outlet, Y, we add the loss in section A to the loss in section C, which amounts to .6 of a volt.

LESSONS IN PRACTICAL ELECTRICITY

PRACTICAL APPLICATIONS OF CONDENSERS.

An interesting application of a condenser in connection with an inductance is in obtaining a constant current from a constant-potential circuit, and a constant potential from a constant-current circuit.

This method has been suggested for use in series incandescent lamp distribution from alternating current circuits. It has the advantage that any number of incandescent lamps can be installed in series, instead of the number being limited to a multiple of the circuit voltage. That is to say, a single 100-volt lamp may be used on a 1000-volt circuit or 20 such lamps in series, the same current flowing in each instance. It will be seen that this system differs from the usual alternating current in two respects. First, the combined voltage may exceed the voltage between the mains; and second, a lamp may be turned off or short circuited, and the current will retain the same value, thus doing away with shunt boxes.

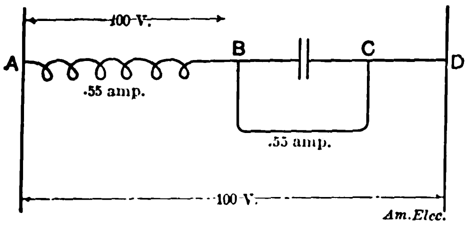


FIG. 1.—CONSTANT-POTENTIAL, CONSTANT-CURRENT CIRCUIT.

This system is illustrated in Fig. 2, where for the sake of the illustration, the voltage between the mains is 100. We will suppose that 110 lamps, each taking .55 amperes, are used in the series circuit. When there is a certain relation between the inductance and the capacity, the latter being in parallel with the series circuit, .55 amperes will flow through the latter circuit whether no lamp is in it, or whether a large number is present, the number only being fixed by the saturation of the iron of the inductance and the strain on the condenser insulation. In practice the arrangement would most probably be used on a high-voltage system, with not necessarily a number of lamps of an aggregate voltage exceeding that of the line.

The relation between the capacity and inductance must be such that when a current of the same value is passed through each, the inductive e.m.f. will be equal to the capacity e.m.f. In other words, the relation is similar to that in the cases previously considered, of an inductance in a circuit nullified by a capacity in parallel or in series. A direct proof could be given that this relation should exist between the two, but for the present it will be assumed, and the method of calculating the value of the inductance and condenser illustrated by an example.

In Fig. 1, suppose that we have a capacity and inductance in series between which the above relation exists; further, suppose that in parallel with the condenser there is a circuit of no resistance, as shown. We will now assume that .55 of an ampere is to flow through the latter circuit, notwithstanding what resistance it may contain, the voltage of the mains being 100 and the frequency 133, or 16,000 alternations per minute.

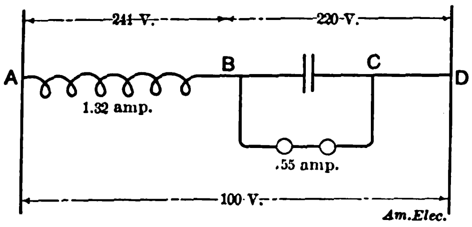


FIG. 2.—CONSTANT-POTENTIAL, CONSTANT-CURRENT CIRCUIT.

Since the circuit in parallel with the condenser has no resistance, there will be no e.m.f. between its terminals B C, and consequently none between the two plates of the condenser, so that the circuit is equivalent to one having in it merely the inductance A B. Substituting in the inductance formula $E = \frac{2 \pi n L C}{1,000}$ (1), the values of E, n and C, we have

$$100 = \frac{6.2832 \times 133 \times L . 55}{1,000}, \text{ or } L = 217.6$$

millihenrys. That is to say, in order that .55 of an ampere shall flow in the circuit, the inductance A B must have a value of 217.6 millihenrys.

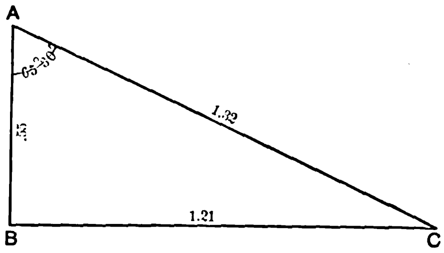


FIG. 3.—CURRENT TRIANGLE.

By definition, the capacity of the condenser should be such that its e.m.f. shall equal the e.m.f. of the inductance with a current of the same value. Our formula for inductive e.m.f. being

$$E = \frac{1,000,000 \, C}{2 \pi n k} \quad (2)$$

this value must be placed equal to (1), since the values of E are assumed equal, which gives us $\frac{6.2832 \times 133 \times 217.6 \times .55}{1,000} = \frac{1,000,000 \times .55}{6.2832 \times 133 \times k}$, or k = 6.58 microfarads.

Referring now to Fig. 2, suppose that in the circuit in parallel with the condenser two 110-volt lamps are placed in series, a lamp taking .55 amperes normally. Since the two lamps are in series, the voltage necessary to send the normal current through them is 220 volts.

To find the value of the condenser current in this case, we substitute in (2) the value of E, or 220, n = 133 and k = 6.58, which gives C = 1.21.

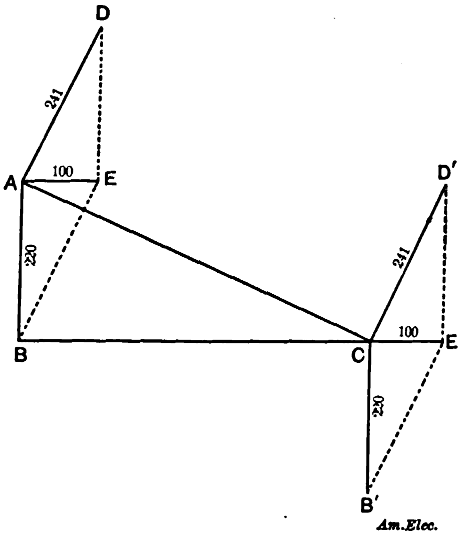


FIG. 4.—E.M.F. TRIANGLE.

It has been shown in previous articles that a current passing through a capacity leads the e.m.f. 90 degrees; on the other hand, a current passing through a plain resistance is in phase with the e.m.f. Consequently, referring to Fig. 3, if A B represents the current passing through the lamps, then B C will represent the current passing through the condenser, and the resultant of these two currents, or the main current passing the inductance, will be A C. Solving the triangle, we find the value of the current passing through the inductance is 1.32 amperes. Substituting this value of current in (1) and also the value of L and n, we have $E = \frac{6.2832 \times 133 \times 217.6 \times 1.32}{1,000} = 241.$ That is, though the e.m.f. between mains is but 100 volts, the e.m.f. between A and B is 241 volts, and the e.m.f. between B and C is 220 volts.

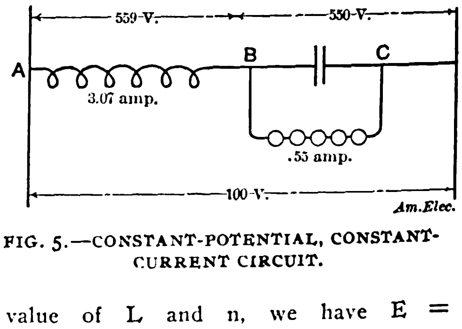


FIG. 5.—CONSTANT-POTENTIAL, CONSTANT-CURRENT CIRCUIT.

To prove now that our supposition concerning the relation between the inductance and capacity is justified, we have to show that the resultant in the above case between 241 and 220 volts is 100 volts.

Referring to Fig. 4, the triangle A B C is, to a different scale, the current triangle of Fig. 3. Since the main circuit A B contains an inductance, the current differs in phase from the e.m.f. by 90 degrees. If, therefore, we draw the line A D perpendicular to the line A C, it will represent the direction of the inductive e.m.f. Since the current in the lamp circuit is in phase with the e.m.f., A B will represent the relative direction of the e.m.f. in that circuit. If now the length by scale of A B is 220, and the length of A D is 241, the resultant of these two e.m.fs., or A E, will be found by measurement to be 100 volts, which proves the supposition made concerning the relating between the inductance and capacity. An analytical proof could also be given. To the right of the figure is another proof, in which the capacity enters, which is left to the reader without explanation.

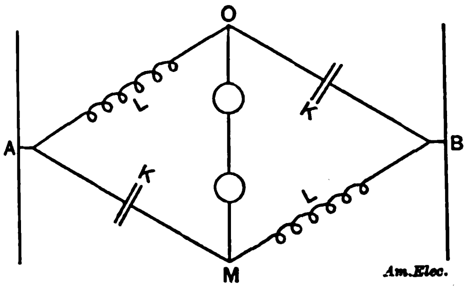


FIG. 6.—CONSTANT-POTENTIAL CONSTANT-CURRENT CIRCUIT.

The data of Fig. 5 illustrates the case where there are five lamps in the circuit in parallel with the condenser, the main current and inductive voltage being found as in the case of Fig. 2.

Boucherot, who proposed the above arrangement* in 1890, has recently modified it as shown in Fig. 6. Here, instead of only one condenser and one inductance, there are two of each, the object being to nullify the idle current. In the case of Fig. 3, the current flowing in the line is 1.32 amperes, and as the voltage across the mains is 100 volts, the apparent watts, or volt-amperes, are 132. On the other hand, there are utilized at the lamps, .55 times 220 =121 watts; in other words, the line current is larger than the useful current in the proportion of 1.32:1.21, or part of the line is so-called idle current. It can be shown, however, that the more lamps there are placed in parallel with the condenser, the less becomes the value of the "idle" current, so that the modified arrangement of Boucherot only has value in special cases.

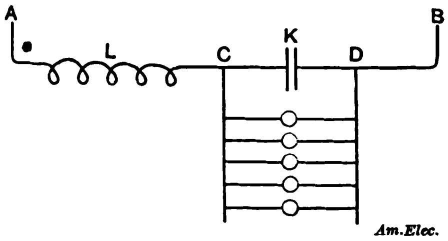


FIG. 7.—CONSTANT-CURRENT, CONSTANT-POTENTIAL CIRCUIT.

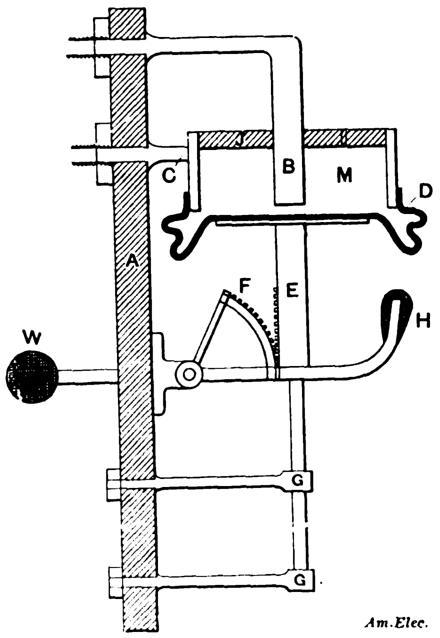
A very singular conclusion from the case illustrated in Figs. 1-5 is that when the circuit in parallel is a short circuit, the flow of current is a minimum; and that when this circuit is broken, the flow is a maximum, the inductance-capacity series circuit then acting, in fact, as a short circuit across the mains.

In the cases above considered, when a constant potential exists between the mains, there is a constant current in the circuit in parallel with the condenser. Referring to Fig. 7, if the inductance and condenser were placed in a constant current line, A B, then a constant potential would always exist between C and D, notwithstanding the number of lamps, or other resistance in that circuit. As the value of the inductance and capacity would be calculated by the same method as given above, this most interesting application of the principle just considered need not be further dwelt upon.

Letters on Practical Subjects

To the Editor of American Electrician:

The accompanying sketch shows a switch for very high voltages and heavy currents, which may be operated without any danger. The special feature of this switch is that there are no moving parts in the circuit, and that there will be very little arcing.



SWITCH FOR HIGH VOLTAGES.

The following references to the illustration will enable the construction of the switch to be very clearly understood: A is a switchboard panel; B and C are contact; D is a rubber bottom and E a supporting rod. F is a gear on the arm H; G, G are binding posts; W a counterweight; M mercury, and J a hard rubber cover.

HENRY P. J. VAN DETH.

Montclair, N. J.

Dry Cells.

To the Editor of American Electrician:

In his letter in the February issue Mr. N. T. Jarvis stated that one of his dry cells gave a current of a little more than ½ amp., while 8 cells gave a little less. I assumed that this was the current indicated on short circuit through an ammeter and based my remarks on this assumption.

The voltmeter Mr. Jarvis employed may be fairly accurate, but on account of its low internal resistance it is not suitable for measuring the voltage of cells having such a large internal resistance as these. The voltmeter indicated the correct voltage of storage cells, but the internal resistance of these cells is probably at least thirty to forty times less than that of the dry cells, so its effect becomes insignificant. The cause of the supposed discrepancy in the voltmeter reading was fully demonstrated by Mr. V. C. Wynne in your April number, who reaches the same conclusions as I did, and it will therefore be unnecessary to go into this any deeper.

It is easily shown that twenty-four cells connected in two rows would give the desired current. Doubling the e.m.f. and keeping the total resistance in circuit constant would double the current. Doubling the number of cells would double the e.m.f., but it also increases the total resistance in circuit by the internal resistance of six cells. But by placing another row of twelve cells in parallel with the first twelve we halve the resistance of our battery, which is now equal to the resistance of the original battery of six cells. The cells are now working under exactly the same conditions as the six cells were, which may be proved as follows:

Denoting the resistance of the external circuit by R, and the current sent through it by six cells by C, we have for the watts delivered to the external circuit, C^2R. Now doubling the current it becomes 2C, and the watts $(2C)^2R = 4C^2R$. The energy delivered is therefore four times as large as in the first case, and it will take four times the number of cells to supply it if they are to work at the same rate of discharge as the six cells did.

P. M. HELDT.

Chicago, Ill.

To the Editor of American Electrician:

There is evidently something uncanny and mysterious and altogether unsatisfactory about those dry cells of your correspondent, Mr. Jarvis, or else he has forgotten his previous statement about them in the February issue, or the printer is sadly to blame.

In the February number we are told that "the current from eight cells is a little less than ½ amp., and the current from a single cell is a trifle more than ½ amp."; whereas, in the April issue he states that "the current derived from each cell was, by ammeter, about 1-6 amp."

If both these statements are true the cells have gone from bad to worse and the sooner Mr. Jarvis discards them entirely the better for his peace of mind. As stated in my former letter, a dry cell with an internal resistance of even 2 ohms is well-nigh worn out, but 6 ohms resistance is so much worse.

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*The mathematical theory is given in Steinmetz's "Alternating Current Phenomena," pp. 76-82.

There is no reason to assume anything the matter with the voltmeter used, as the resistance of the cells accounts for the fall in the voltage reading. Even in the case of the small storage cells used, the reading of the voltmeter would not be exactly proportional to the number of cells in series on open circuit (so-called), but as the resistance of each cell cannot well exceed 2 ohms, the difference with five cells would be only about .3 volt and not readily noticeable except on a more delicate instrument. With a higher-resistance voltmeter the error would be less.

The mathematical explanation of Mr. Heldt's statement is as follows, and of course this assumes a constant voltage and resistance for each cell: Let E = voltage and R = resistance of 1 cell; r = resistance of all the circuit except the battery; n = number of cells in use at first. Then $\frac{nE}{nR+r} = C$, the current flowing at first. Now, if we double the number of cells in series, we have $\frac{2nE}{2nR+r}$ = the current then flowing, which has a value uncertain and depending on the relative values of R and r. If we put two similar cells in multiple, we virtually double the size of our cell, and therefore halve the resistance; and, if we put two sets of 2n cells in multiple (or parallel), we have $\frac{2nE}{nR+r} = 2\frac{nE}{nR+r} = 2C$, or double the original current. Mr. Jarvis will notice, however, that if R, the resistance of the cells, is very small in comparison with the outside resistance r, then n R in the equation may be almost neglected and the current becomes nearly proportional to the number of cells in series. V. C. Wynne.

Utica, N. Y.

◆

ELECTRICA CATECHIS

202. What sort of field exists between the poles of a magnet?

The lines of force go from one pole to the other in nearly straight lines. Between parallel surfaces the lines are straight. The lines of force beyond the parallel surfaces are curves, somewhat as shown in Fig. 1. The magnetic force becomes less and less intense as the distance from the magnet increases, as shown by the lines of iron particles being less and less distinct.

203. What reason is there for believing that the lines of force tend to follow the easiest path possible?

This is a conclusion from the facts that particles of iron are drawn into the magnetic field; that the magnetism is much stronger when its path is largely or entirely through iron; and that the lines tend to become as short as possible.

204. How can it be shown that the lines of force tend to become as short as possible?

This is illustrated by the well-known phenomena of attraction, as when a magnet attracts its keeper. Familiar examples are the telegraph sounder and the electric bell.

205. What is meant by a magnetic line of force?

The term is used either to indicate the direction of the force, or more commonly as a measure of the strength of the field. Perhaps the simplest way to get an idea of the strength of a magnetic field of one line of force is to consider that a wire moving through a magnetic field so as to cut or cross 100,000,000 lines of force per second generates an electromotive force of one volt.

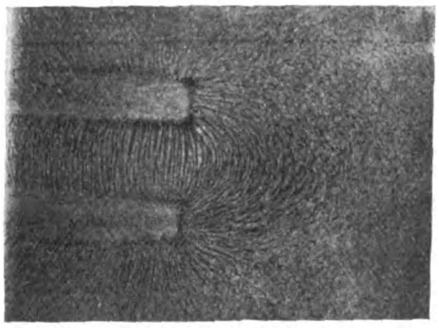


FIG. 1.—MAGNETIC PHANTOM.

206. How is the attraction of unlike poles and the repulsion of like poles explained?

There is no complete explanation agreed upon, although all the actions can be referred to simple laws. There is a tension along the lines of force and a pressure at right angles to them; in other words, the lines tend to shorten and to spread apart with a definite and known force.

207. With how much force do the magnetic lines tend to spread apart?

The force measured in dynes equals 0.08 times the square of the number of lines per square centimeter.

208. With how much force do the lines tend to contract or shorten?

With a force one-half the pressure, or 0.04 times the square of the number of lines per square centimeter.

209. What is an example of a simple motor based upon the attraction of two magnets or between a magnet and a piece of iron?

The electric bell, the telegraph sounder or relay and the telephone receiver are simple electric motors.

210. Explain the principle of the electric bell.

An electric bell outfit consists of four essential parts, the bell, the battery, the push button or switch, and the connecting wire. When the button is pushed the circuit is closed, and current from the battery passes through the circuit. In the bell it passes through the coils of an electro-magnet, thereby magnetizing its soft iron core. This attracts the soft iron armature and draws it closer to the coils, and thus the hammer at the end of the armature strikes the bell. But when the armature is drawn up the spring behind it is drawn away from the contact screw, and thus opens the circuit and stops the current. This causes the iron core to lose its magnetism, so that it can no longer hold the armature against the pull of the tension spring. The armature, therefore, falls back until its spring touches the contact screw, when the circuit is closed again, and the same action is repeated. Thus the armature oscillates back and forth, opening and closing the circuit automatically, and we have an elementary motor, which operates so long as the circuit is closed at the push button or switch. The principal parts of the bell are shown in Fig. 2.

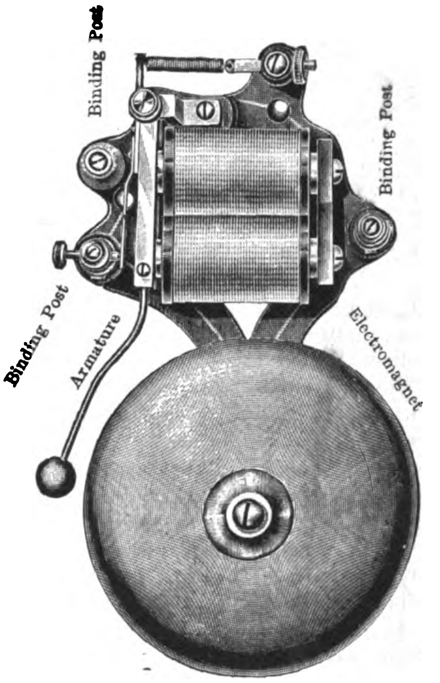


FIG. 2.—ELECTRIC BELL.

211. What is a "single stroke" electric bell?

The vibrating contact is removed so that there is no automatic make-and-break in the bell itself. The armature is therefore attracted only once, and strikes the gong one blow each time the circuit is closed at the switch. It is thus suitable for giving signals.

212. What is an electro-mechanical bell?

Electro-mechanical bells are usually single stroke. When the magnet attracts its armature this releases some sort of a catch or trigger that sets free a train of clockwork which strikes the gong a harder blow than would be practicable with the magnet alone. The electro-magnet thus acts as a sort of relay or starter, while the blow on the gong is struck by a mechanism driven by a spring or weight.

213. What is a buzzer?

A buzzer is electrically the same as an ordinary electric bell, except that there is no gong. The armature vibrates rapidly and makes a buzzing noise that is sufficient to attract the attention of a person near by.

QUERIES AND ANSWERS

What margin of h.p. is usually allowed between the indicated h.p. of an engine and the total out-put of a dynamo? L. E. S.

The horse power should be about twice the kilowatt capacity of the machine.

What is a good varnish for copper? J. K. B.

One part of carbon di-sulphide, 1 part of benzine, 1 part of turpentine, 2 parts of methylic alcohol and 1 part of gum copal.

What is the rate of deposition of electrolytic copper? S. N.

About one pound per 450 ampere-hours. The current density is about 10 amperes per square foot, counting both sides of the anode.

How can the three-wire system be operated from transformers? C. M. A.

By placing two transformers in series and running the neutral from a point between the two. Three-wire transformers are manufactured with a neutral connection to the middle point of the secondary.

Is there any rule for the allowable current density in interior electrical conductors? J. B. S.

One thousand amperes per square inch is the rule used in the navy, but in work ashore the current density or carrying capacity is fixed by the Underwriters' electrical code.

How can the polarity of an electrical source be determined? L. E.

Connect the two poles or two sides of the circuit to be tested with two small pieces of lead dipping in a glass of water, acidulated with sulphuric acid. The piece of lead connected with the positive side will turn brown.

Why is concentric wiring not permitted in this country by fire underwriters? N. M.

We do not know the reason. Concentric wiring has given much satisfaction abroad, being very largely used in Great Britain. It would appear to involve less fire risk than the ordinary system of wiring, besides being cheaper to install.

Why does joining in parallel of two circuits of a transformer secondary reduce the voltage? L. E.

If two cells of primary battery in series are connected in parallel, the voltage will be halved; since the two parts of the secondary circuit are also seats of e.m.f., the same result will follow if they are placed in parallel.

Would it not be advisable to wind a 20-k.w. smooth core bipolar 110-volt direct current machine, with strip copper, in place of the six wires in parallel with which it is at present wound? J. S. J.

It would not be advisable on account of the loss of eddy currents that would ensue. Strip conductors may be used in slots, but not on a smooth core.

What are the core dimensions and windings of a telephone transmitter induction coil? N. L. D.

For granular carbon transmitters, on a core of soft iron wires, 4¾ ins. long by 1" in. in diameter, wind about 150 turns of No. 36 wire for the primary. For the secondary, about 4000 turns of wire of the same size may be used.

I have made a static machine, but it will not excite. The glass plates are 3¼ ins. apart, and there are two Leyden jars, both connected from the inside. J. W.

The plates are too far apart. The outside coatings of all the jars should be connected, and the inside coatings of the jars carrying one comb should be carefully insulated from the inside coatings of the set carrying the other comb.

What is the voltage of a sulphate of mercury cell, and is such a cell subject to local action on open circuit? C. S. H.

The Marie-Davy type of cell referred to is merely a Bunsen cell, in which the nitric acid is replaced by sulphate of mercury, and, as in the case of the Bunsen cell, there is no local action on open circuit. The voltage varies from 1.3 to 1.5, depending upon the degree of acidulation.

If a spectrum of light from an arc lamp were obtained through a prism, what would be the effect if a thermometer were slowly passed from one side of the spectrum to the other? G. H.

The mercury would rise in the thermometer as it was moved from the violet toward the red ray, and would continue to rise for some distance beyond the latter. The heat spectrum has its maximum beyond the red, and overlaps the light spectrum.

I have been unable to make T. H., Brush and W. E. lamps work on the same circuit. Is there any reason for this? D. B.

Brush and T. H. lamps will not work well on a closed coil arc machine, these and some other types requiring the pulsating current of the open coil, or T. H. or Brush machines, in order to create a slight vibration in their mechanisms to keep them from sticking. A differentially wound lamp will also not work well with shunt wound lamps.

What is a good insulating material for wood bobbins and cores? J. L.

A French recipe is for a mixture of 10 parts of yellow rosin and 1 part of white wax. First dry the bobbins during five hours at a temperature above the boiling point, and then quickly plunge them into the mixture, the temperature of which should be about 350 deg. F. After the bobbin is inserted let the mixture cool and take out the bobbin when it becomes slushy. The covering on the surface is removed by warming the bobbins.

Why is the cross section of one of the wires of a three-phase line taken at half the cross section of one of the wires of a direct current line transmitting the same energy? H. H. B.

Calling the cross sectional area of one conductor of the last mentioned line A, the total cross section will be 2 A. In the three-phase system there is a saving in copper of 25 per cent, which reduces this cross sectional area to 6A : 4. Since there are three wires the cross section of one wire will consequently be one third this, or ½ A.

We have a T. H. 30 h.p. railway motor which we wish to change to a shunt motor. How may this be done? H. A. T.

Knowing the current used normally by the machine running as a series motor, multiply this quantity by the number of series turns, which will give the ampere turns of the shunt motor. Assuming that two amperes will be used in the shunt, the number of shunt turns will be found by dividing the above quantity by two, and the resistance of these turns will, for a 500-volt circuit, be 250 ohms. If three or four amperes are used, the resistance will be correspondingly reduced.

Why does a machine have a different rating as a motor and as a dynamo? J. P. L.

Assuming the same current in each case, and the same E.M.F. at binding posts, the motor will have less power: First, because the E.M.F. absorbed in the armature does not appear at the binding posts in the case of the dynamo, but does in the case of the motor; if this is 10 volts, the electrical energy in a 110-volt dynamo is $C \times 120$, and that in the motor, $C \times 100$. Second, in the case of a dynamo the mechanical losses of friction are supplied mechanically at the pulley, but in the case of a motor, must be subtracted from the electrical energy supplied. A good rule is that a motor will develop at the pulley 75 per cent of the pulley power required to run the same machine as a dynamo, the voltage and current being the same in each case.

Will you please explain the following occurrence which recently came under my observation: A telegraphic wire was grounded 30 miles from a city, the wire being connected with other offices on both sides. Soon after grounding the sounder clicked, showing that the current was on, and almost immediately a musical note was emitted, the sound filling the entire room and being of about the note E in pitch. This was continued for nearly two minutes, and then ceased. All the line current was supplied from the city, from which the line wire runs on the same poles as the telegraph wires of a railroad line. S. L.

A number of causes may be given, such as an alternating current at some point getting on to the wire, a cross between the coil and core of the relay, a buzzer inserted in the circuit somewhere for fun or otherwise; an imperfect vibrating contact would perhaps set up a tone; the box of the relay probably acted as a resonator, making the effect more pronounced.

What means of protection have been adopted to prevent primary currents from entering buildings, due to the breaking down of transformers from lightning and other causes? S. S.

The Cardew earthing device, much used in England, consists of a piece of aluminum foil, one end of which is fastened to a plate connected to the primary, the other end being attracted to an opposite ground plate when the primary is connected with a grounded secondary, the primary thus being grounded. The Thomson film cut-out is a thin film of paper placed between two plates, connected as above, which is pierced by a potential of 300 volts. The Thomson ground shield and grounded secondary consists of a sheet of metal placed in the transformer between the primary and secondary windings in such a way that it is impossible for any current to pass from the primary toward the secondary without encountering the metal shield, which is grounded.

New Apparatus and Appliances.

HIGH VOLTAGE INSULATORS.

In the descriptive account of a new type of high-voltage insulator, on page 178 of April issue, the following paragraph was omitted by the printer.

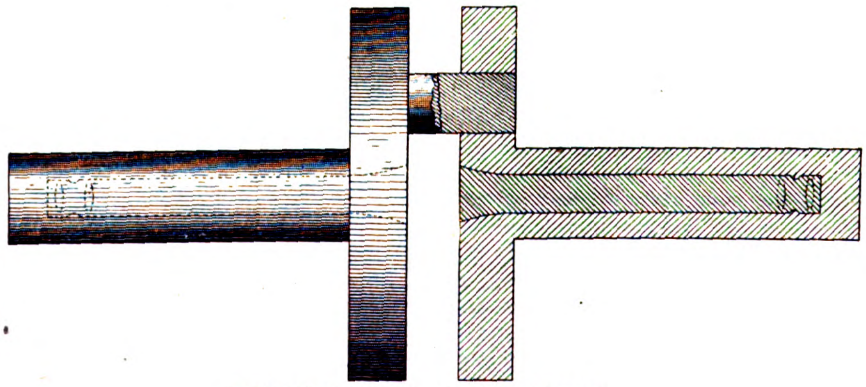
The insulators being made of a high-grade porcelain body, thoroughly vitrified, and with the glazing as described above, reduce the danger of a breakdown through puncturing between the conductor and iron pin to a minimum. This type of insulators is manufactured by the R. Thomas & Sons Company, East Liverpool, Ohio, under the "Boch" Patent No. 600,475, issued March 8, 1898.

COMBINED CRANK SHAFT AND DISK.

The crank shaft construction shown in the accompanying illustration consists of a shaft and disk of one piece of gun metal or one integral casting, with a steel core or strengthening rod cast in the center of the shaft and made a part thereof.

In casting, the strengthening core is supported in a mold and the metal poured or cast so as to form the disk and the shaft covering the core, the latter being flared at the disk end and scored at the opposite end. The core is heated to a degree which will enable it to become fused with the molten cast metal surrounding it, thus establishing a firm physical union between the core and the cast portion.

This construction has been used by A. L. Ide & Sons, Springfield, Ill., for several years past, and on April 5 a patent was issued in the name of the late A. L. Ide. We are informed that out of several thousand engines equipped with these shafts, not one has failed to withstand the greatest strain of the most exacting service. It has also been found that the gun metal makes a more serviceable, better wearing and more perfect journal than a shaft where the steel comes in contact with the babbitt of the bearing.



COMBINED CRANK SHAFT AND DISK.

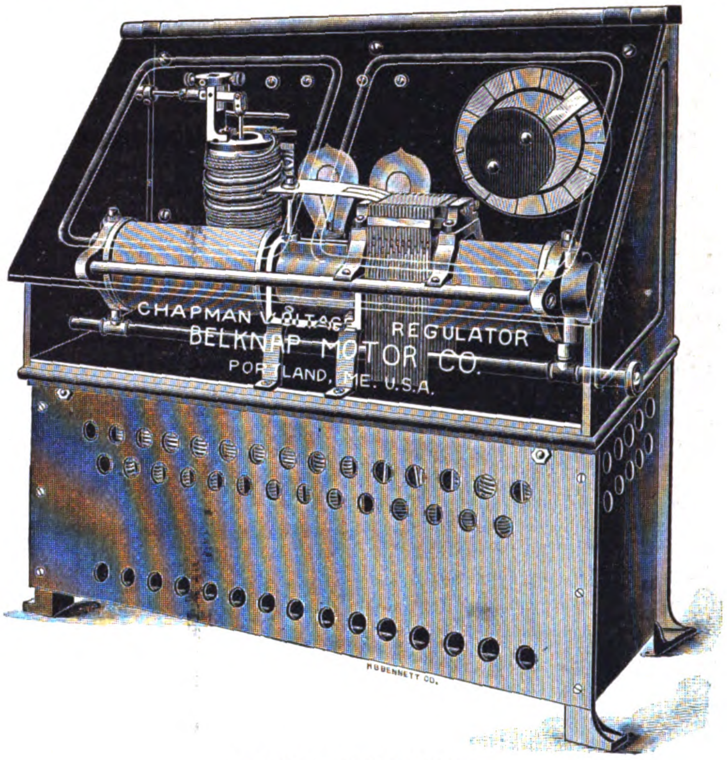
VOLTAGE REGULATOR.

The new type of voltage regulator shown herewith consists of three essential parts—a set of resistance coils to be inserted or removed from the field magnet circuit of the generator to be regulated; a working solenoid to do the work of inserting and removing the coil from the circuit, and an auxiliary solenoid to determine the movement of the working solenoid.

The resistance coils are made of German silver and the size of the wire used is such as will afford ample capacity to control the field current of the generator for which it is constructed. These coils are connected to a series of copper segments placed in a horizontal row, and having a contact slider arranged to move over their surface. This contact slider is operated by being mechanically connected to the moving core of the working solenoid.

The working solenoid consists of two differentially wound coils of wire placed on a brass tube, one at each end of the tube, and the whole placed in a horizontal position. The middle portion of the tube is left vacant. Inside of the tube is fitted a soft iron plunger somewhat shorter than the distance through the two coils; at the center portion of the plunger a rod is attached which passes out through a longitudinal slot cut in the vacant portion of the tube. The contact slider above described is attached to this rod and so moves with it and with the iron plunger.

In order to prevent too quick a movement of the plunger, a very simple and ingenious retarding device is used, in which the moving iron plunger is made to serve the purpose also of an oil pump. From one end of the brass tube to the other a small pipe is connected, having a hand valve in it, to regulate the flow of oil. The two ends of the brass tube, together with its connecting pipe, are completely filled with oil and closed up tight. The movement of the iron plunger toward either end can then take place only as it displaces this oil and causes it to move through the pipe and to the other end, the rapidity of which movement can be very finely adjusted by means of the valve above described.

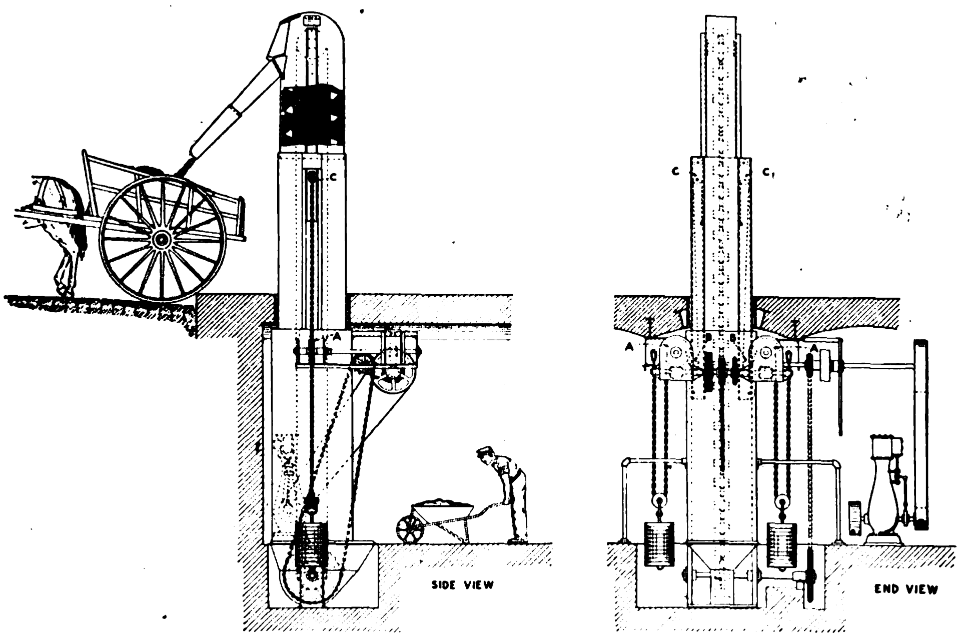


VOLTAGE REGULATOR.

The force tending to move the iron plunger depends on the balancing against each other of oppositely wound coils, and this balancing is determined by the action of a small auxiliary solenoid whose only work is to cause one or another of two platinum pointed screws to make contact with the brass lever supporting its core. Contact with one screw causes perfect neutralization of the differential coil at one end of the working solenoid, and so disturbs the balance and causes the plunger to move forward the other coil; contact with the other screw causes neutralization of the coil at the other end and a movement in the other direction. The small solenoid may be wound to suit a variety of purposes, any one of which may be required in fulfilling the demands of station regulation.

First, it may be wound with a simple fine winding to be connected as a shunt across the lines to be regulated, and in this case it will secure constant-potential regulation at the point of attachment to the line.

Second, it may be wound with a fine winding as before, and also with a coarse winding, the fine winding connected as a shunt to the line, and the coarse winding in series with the line. In this case it will regulate for constant potential at some distant point on the line which may be predetermined by the setting of an adjustable compounding switch provided as a part of the regulator.



TELESCOPIC ASHES ELEVATOR.

Finally, the small solenoid may be wound with a single coarse wire placed in series with the line; in this case it will secure regulation for constant current in the lines.

But whatever be the nature of the regulation, the small solenoid will perform its duties with an accuracy as close as 1 per cent above or below the normal, and is adapted to either direct or alternating currents. Alternating currents are especially capable of close regulation by this instrument, as the slight jar incident to its flow through the small solenoid almost entirely eliminates the element of friction at the pivots of the lever supporting the core, and it will easily recognize a change of ½ of a volt on a 110-volt circuit.

The Belknap Motor Company, of Portland, Maine, manufactures the regulator described, known as the Chapman voltage regulator.

TELESCOPIC ASHES ELEVATOR.

The ash-handling apparatus illustrated herewith is being installed by the U. S. Appraisers' Warehousing Company, in New York City, and will handle ashes at the rate of 18 tons per hour. The outline sketch shows it in operating position. The ashes are thrown into the hopper-shaped boot, and buckets attached to a single strand of chain scoop them from the bottom of the boot, carry them over the head wheel of the elevator and drop them into the inclined discharging chute. The boot, about 3 ft. deep, is placed below the floor line of the basement, making it an easy matter to dump the ashes into it.

To comply with the legal requirement that the elevator shall not permanently obstruct the sidewalk, the machine is so made that when not in use the part above the pavement may be telescoped into that in the basement; hence the name of the device. From the floor level to the sidewalk is a distance of 11 ft., and as the upper portion of the elevator is about 13 ft. long, it is necessary that this part shall be in two sections. The upper of these is designed to telescope into the lower, thus making it possible to slide the 13 ft. above ground into the 11 ft. erected below the surface.

The second and third sections, constituting the upper portion, when being hoisted are slid on wheels and rollers set in the channel iron sides of the structure, which minimizes frictional resistance. This, together with the counter weights employed, makes raising a matter in which the motive power is found to be an inappreciable quantity.

The raising is done by two sets of worm gearing, chains and counterweights. The chain passes from its counterweight and over the wheel "A," which is actuated by the driving worm shown. The wheel "B" is on the lower end of section two. The chain running under it completes the first portion of the leverage, and thus the second section may be placed in working position. In like manner the third section is hoisted, the chain continuing to and over the fulcrum wheel "C," at the top of section two, and being fastened at the lower end of No. 3 section. In lowering, the worm gearing is run in a reverse direction, and as the sections descend, the counterweights rise to the ceiling of the basement. The projecting discharge chute and the hood above it are folded over the top of the elevator previous to the operation of telescoping and disappear with it.

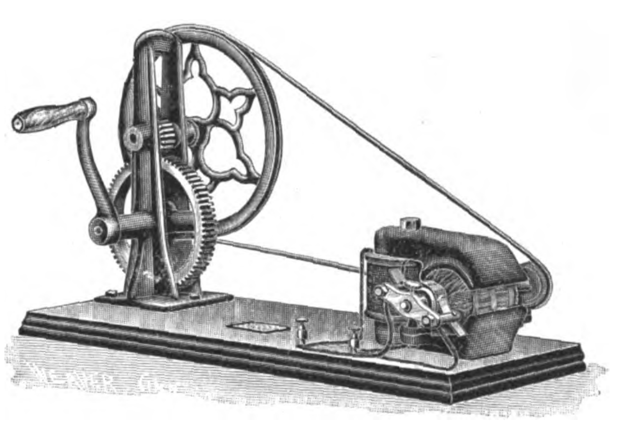
That the elevator shall not drop the ashes except into the carts, it is completely inclosed in a steel casing. The hoisting and lowering mechanism is outside of this casing, and the worm gearing, which runs in an oil bath, is covered by a housing so that ashes cannot come in contact with these parts.

Some time since, to meet the demand for a chain that would stand the hard service of conveying and elevating the gritty material of the South Africa diamond fields, there was devised a chain known as the "Ley Bushed," which consists of strong malleable-iron links fitted with steel bushings and pins. These bushings and pins take all the wear that comes on the chain, and after being worn out may be replaced at a comparatively small cost. A chain like this is particularly desirable for handling such an abrasive material as ashes, and it is employed in the elevator described.

The machine described above was designed and is being built by The Link-Belt Engineering Company, of Philadelphia and New York. During the earlier stages of the evolution of this machine, they installed somewhat similar outfits at the Waldorf Hotel, New York City, and at the Philadelphia City Hall.

MODEL EXPERIMENTAL DYNAMOS.

In the accompanying cut is shown an experimental machine designed for the instruction of students and the use of amateur investigators. It has an output of 75 volts, and is made for either direct or alternating currents, or for both combined. This machine, which is wound for any voltage from 5 to 25, is made by the T. & H. Electric Company, Eldridge, N. Y.



MODEL DYNAMO.

ELECTRIC ELEVATOR WITH NON-REVERSIBLE MOTOR.

The electric elevator shown in Fig. 1 possesses the rather novel feature of being a strictly high-duty machine in which the motor runs in but one direction. The reversal of the movement of the car is accomplished, not by means of some complicated electrical device, but by a mechanical expedient which has stood the test of half a century, that is, friction gearing. In taking up the problem of electric elevators, the manufacturers considered that with the rapid manipulation made necessary by modern practice no system in which the motor is started, stopped and reversed with the car would meet the requirements.

In carrying out this idea in practice, upon the worm shaft are mounted two bevel iron friction gears, either of which may be engaged with a specially prepared paper friction gear upon the motor shaft, the engagement with one iron friction gear producing the upward movement of the car and the engagement with the remaining one the reverse movement, the motor, as before stated, being non-reversible.

Believing that the whole apparatus should be built in one shop, the next step was to bring out a suitable motor and controller, the result being the inclosed multipolar motor and auto-starter shown. The latter is entirely mechanical in action and free from magnets and dash-pots, the rheostat being manipulated by a centrifugal device mounted upon the motor shaft, thus giving a positive control of the resistance.

The motor field is in one piece of cast steel, with diagonal pole pieces. The armature is slotted to receive machine-wound coils of uniform length, giving an armature symmetrical both electrically and mechanically. The method of winding is shown in Fig. 2, which is a half-finished armature in process of winding.

A system of rating has been adopted for this apparatus based upon speed as well as output. The normal rating is for the output at a uniform speed of 1000 r.p.m., a table showing, however, the output at other speeds.

The manufacturers of the elevator described are the Armitage-Herschell Company, North Tonawanda, N. Y.

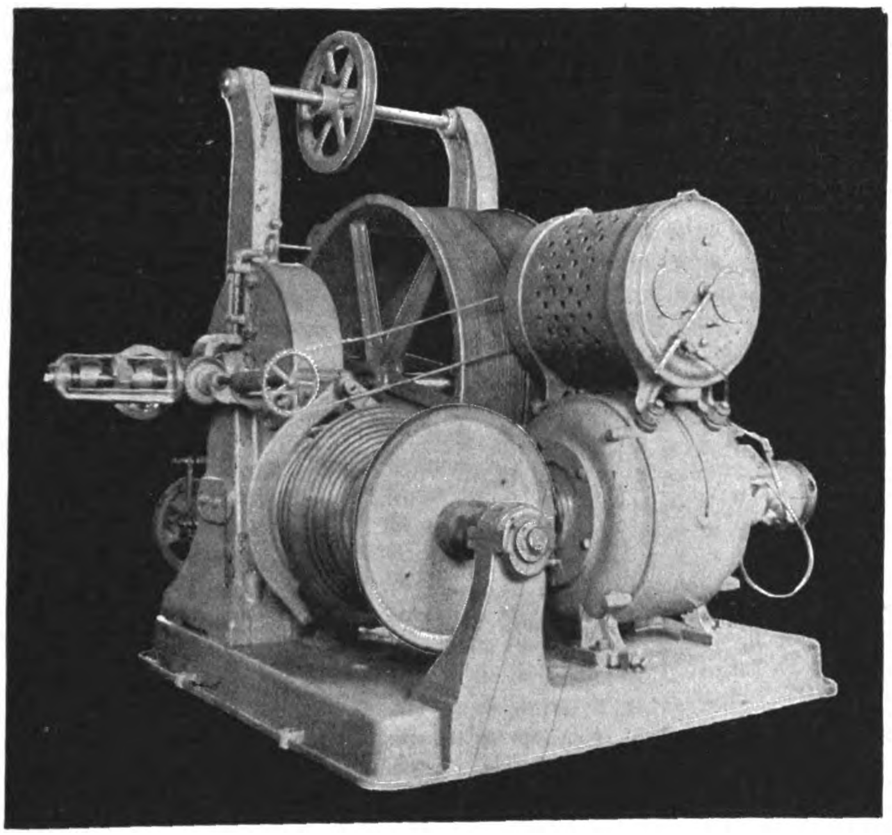


FIG. 1—ELECTRIC ELEVATOR WITH FRICTION GEARING.

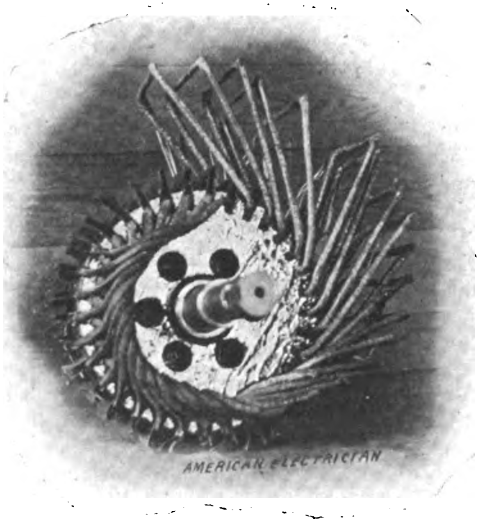


FIG. 2—MOTOR ARMATURE.

STREET CAR ELECTRIC HEATER.

A new type of street car electric heater is shown herewith in one of its forms, which, as will be seen, is highly ornamental in appearance and in keeping with the finish of modern cars. The heater shown is constructed for placing under seats without panels, and may be fastened either to the floor of the car, to the side, or to the under part of a seat. It will be noticed that the shape of the shell containing the heater is such as to allow all heated air to escape freely and quickly from the inner case, the hottest air thus not being retained in the shell to cause discomfort to those sitting above it.

The heater proper consists of a resistance coil of non-oxidizable wire, which is wrapped back and forth around the core. This latter is built up of sections of porcelain placed upon a square iron bar, the wire being looped back and forth over the projection shown. It will be noted that

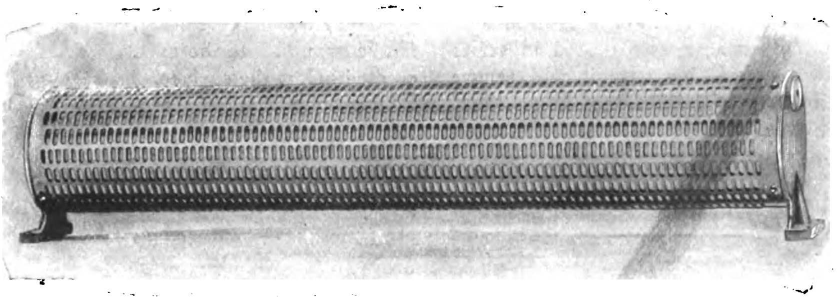


FIG. 1—ELECTRIC HEATER.

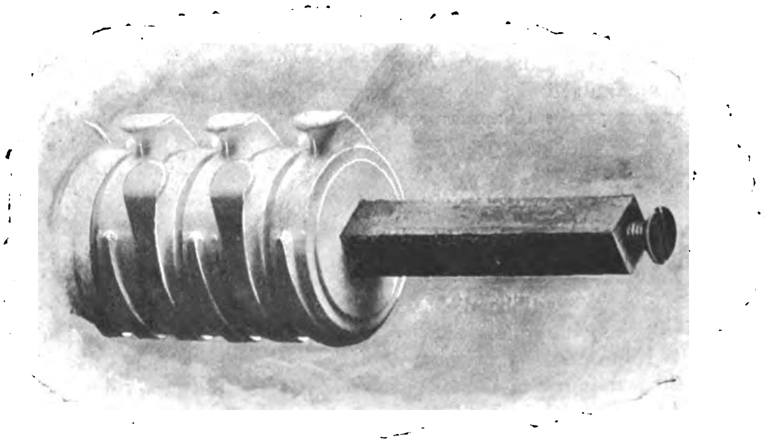
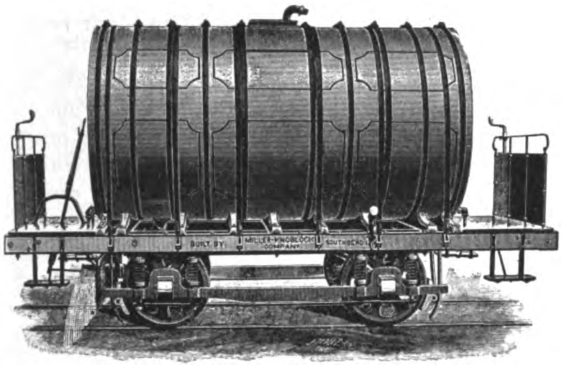


FIG. 2—CORE OF ELECTRIC HEATER.

there is a groove formed by the porcelain sections of the core, which allows a circulation of air between the resistance coil and the core, thus materially increasing the radiating surface of the coil and the effectiveness of the heater. The construction of the heater is also such that the resistance coils may be easily cleaned of any accumulations of dust. The manufacturers of this type of heater are the Safety Car Heating & Lighting Company, 160 Broadway, New York City.

ELECTRIC CAR SPRINKLER.

The sprinkling of streets by means of electrically propelled cars seems to be in line with the modern idea of progress, and we illustrate herewith such a car which has come in quite general use. The cars are of two styles, one which operates by gravity only, the width of the spray consequently being limited. These cars are used for sprinkling the tracks and a few feet outside of the outer rail, and are for such sprinkling as is done by street railway companies for their own and their patrons' benefit. It has been found that wetting the rails and the space between them is of considerable advantage, on account of keeping the dust out of the journals and motors, and out of the cars, besides increasing the conductivity of the rails.



STREET-CAR SPRINKLER.

The wide-throwing electrically operated cars are intended for sprinkling the street to the curb, and from them the water is thrown from 30 to 40 feet outward. They are fitted with electric ejectors which throw the water outward and cover the street between the track and the curb, the operation being instantly regulatable. A technical description of these cars is contained in a circular issued by the manufacturers, the Miller-Knoblock Company, South Bend, Ind., from whom a copy can be obtained on application.

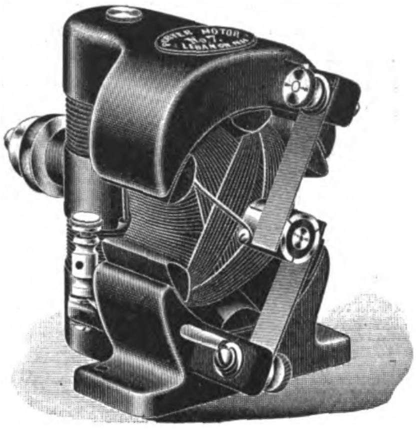
BATTERY MOTOR.

The motor illustrated herewith has been designed for the highest efficiency, and though intended more particularly for use with batteries, it is also wound for 110-volt direct current circuits. The armature has six poles and revolves in a single recessed brass-bushed bearing, thus insuring the least possible friction. The field connections are made inconspicuous by leading the terminals through the field poles to the binding posts, which also safeguards them. The commutator is made of brass tubing in three or six segments mounted on hard rubber. The brushes, which are of hard spring copper, are easily adjusted or removed by means of thumb screws. The machine is supplied with a lubricating device. The motor weighs only 5 lbs., but is capable of carrying an 8 or even a 10-in. fan, if mounted on a bracket. It is finished in black or colored enamel, with full nickel-plated trimmings, and is run from two cells in primary battery.

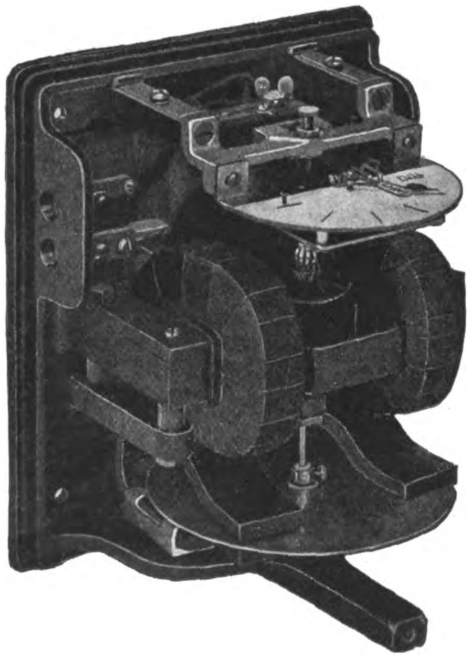
The motor described is made by the Porter Standard Motor Company, Lebanon, N. H.

STORAGE BATTERY METER.

The General Electric Company has developed a special type of meter which will show at a glance the amount of energy available in a storage battery. The meter resembles in general appearance the standard Thomson recording wattmeter, and is, in fact, a development from it, the mechanism being almost exactly similar. The meter is provided with a single indicating needle moving over a horizontal semi-circular dial.



BATTERY MOTOR.



STORAGE BATTERY METER.

The essential requirement for a storage battery meter is that the armature shall rotate in either direction and give equally accurate readings in both. In this meter this requisite is fully preserved. The energy put into the cells is, therefore, added to the reading of the meter, while the energy withdrawn is subtracted, but to compensate for the loss in the cells the meter runs more slowly when charging. The reading of the meter represents, not the amount of energy put into the battery, but the amount available, and when the needle points to zero on the dial, it shows that the battery is completely discharged.

These meters are manufactured with any desired percentage difference between charging and discharging rates, and in all standard sizes. Since, however, this percentage varies in almost every case, the General Electric Company manufactures them only to order.

Electric Motors.

That electricity as a motive power for every class of machinery is bound to entirely supersede steam, is probably quite generally appreciated by power users. Nevertheless, it is also probably true that **the ideas of a great majority of those interested are rather vague on the subject, and** therefore a statement of a few facts will not be without benefit.

Wherever shafting and belting are employed, the waste of power ranges from 25 per cent to sometimes an excess of 80 per cent. Incredible as the latter statement may seem, it can be supported by the result of actual tests. As an illustration, tests recently made by Prof. J. J. Flather at the Baldwin Locomotive Works, Philadelphia, showed that 80 per cent of the power regularly employed was consumed in operating shafts and belts. This, of course, is due to the fact that enough power has always to be transmitted to operate all the shafting and belting, while the machines in this plant, which are of large power, are far from being in continuous operation. Prof. Flather also measured the loss of power in a number of large machine tool works and his report stated that in no one instance did the net loss of power fall below 25 per cent, while the average was 41 per cent. Prof. C. H. Benjamin, in tests of sixteen different factories, each engaged in different kinds of work, found that in no instance did the total waste of power fall below 47.3 per cent, and it ranged as high as 80 per cent.

The printing trade has perhaps been in the lead in taking advantage of the saving incident to the use of electric motors. Among recent installations of this kind are those of the American Book Company and the American Lithographic Company, both of New York. The first mentioned uses motors of the geared type, while the Lithographic Company uses the same type of motor—the Lundell—but direct connected. The engineer of the American Book Company is authority for the statement that not less than $35 per day is saved to his company in the cost of fuel alone, while the American Lithographic Company reports a saving of 44.2 per cent in light, heat and power since the installation of the electrical plant.

A recent notable instance of the recognition by a large house of the economy of electric motors is that of the John Stephenson Company, of Elizabethport, N. J. Each of the machines used in these works will have an independent motor of the Lundell type. The sizes will range up to a 40-h.p., some of them geared and some of them direct connected. This plant will be one of the largest of its kind in the world, and will be a standard illustration of the economy and durability of electric motors.

PERSONAL.

Mr. Chas. Chamberlain has been placed in charge of the press bureau of the Electrical Exhibition. Mr. Chamberlain is one of the best known newspaper men in New York, and on account of his close relations with the metropolitan press and acquaintance with the New York representatives of out of town newspapers his appointment is an ideal one.

Mr. W. F. Osborne, for the past eight years the Eastern manager of the "Western Electrician," has severed his connection with that journal, and will hereafter be identified with the "National Provisioner" as business manager. This journal, which is the leading paper in its field, is fortunate in having secured the services of Mr. Osborne, who had built up an enviable reputation in electrical journalism, and has been one of the most popular of its members in his relations with all identified with the electrical industry.

Mr. W. L. Patterson, for some time past chief engineer of the Union Depot Railway lines in St. Louis, has resigned his position with that road to open an office in connection with Mr. C. L. Wait, formerly of Chicago, and engage in the business of mechanical and consulting engineers. Mr. Patterson's high reputation as a first-class mechanical engineer was well demonstrated by the skillful manner in which he restored order out of chaos when he took entire charge of the wrecked power plant of the Union Depot Railway Company subsequent to the terrible cyclone in 1896. Mr. Patterson's many friends wish him the full mead of success, which his ability deserves.

NEW BOOK.

Modern Switchboards. By Albert B. Herrick, Philadelphia: The Cutter Electrical and Manufacturing Company. 153 pages, illustrated. Price, $3.

Few technical treatises have been produced in this country in a style so elaborate as the present one which, in illustration, typography, paper, printing and binding easily takes rank as an edition de luxe. The titles of the chapters are as follows: Circuit-Breaking Devices; Switchboard Construction; Switchboard Appliances; Protective Devices; Low-Tension Switchboard; Low-Tension Central Station Switchboards; Railway Switchboards; Alternating-Current Switchboards; Arc Light and Special Switchboards; Circuit Breakers and Their Use in Power Transmission; The Development of the Circuit Breakers. As indicated in the sub-title, the work deals largely with switchboard appliances, numerous forms of which are shown in excellent engravings, including several in colors.

BUSINESS NEWS.

J. Jones & Son have removed to 64 Cortlandt street, where they occupy the entire building. The greatly increased space has permitted a large additional stock of goods, bought at very favorable terms, to be laid in, thus enabling close price to be made, and prompt delivery effected.

Incandescent Lamps.—A beautiful specimen of artistic catalogue work has been issued by the Buckeye Electric Company, of Cleveland, Ohio. The various types of lamps manufactured are shown in excellent cuts, and each page contains one or more marginal sketches illustrating an application. The binding, which is of heavy cardboard, is unique, the front cover having a cloth hinge.

Correspondence Instruction.—The Institute for Home Study of Engineering, Cleveland, Ohio, has issued an 1898 edition of its catalogue, which enables a very thorough idea to be formed of the character of the course taught and the methods of instruction. In this issue the name of Prof. E. P. Roberts appears as the head of the department of mechanical and electrical engineering and technical director.

The Ohio Electric Specialty Mfg. Co., Troy, Ohio, is meeting with much success with its lines of rheostats and motor starters, among the features of this apparatus being an improved method of insulating the resistances. The automatic motor starter is fitted with an overload device which affords complete protection to the armature, and speed regulating rheostats are built with a good heating margin. Among the specialties of this company are the "Perfection" brush and the Rogers commutator compound.

Fine Exhibit of the Walker Company, of Cleveland.—The Walker Company, of Cleveland, will exhibit at the Electrical Exposition at Madison Square Garden, New York, two of their No. 20 L motors, mounted on truck; one No. 20 L motor, dismantled to show construction; two No. 4A street car motors, mounted; one 50-k.w. belted alternator; one 50-k.w. street lighting generator, direct connected to Armington & Sims engines, type "S" controllers, assembled and dismantled; railway switchboard complet with feeder and generator panels; ornamental arc lamps; new Walker recording wattmeter, and a large display of photographs of its apparatus. Besides this, there will be a complete section of the new underground conduit with a Broadway car shown in operation. Mr. J. S. Anthony, of the home office, will be in charge, and is now in the city preparing all of the work.

The American School of Correspondence, 156 Tremont Street, Boston, offers to those engaged in electrical pursuits an excellent opportunity to secure a thorough and practical technical education, under the direction of men of acknowledged ability in the engineering field. The school makes a specialty of electrical, mechanical and steam engineering, and has spared no expense to make these courses simple, comprehensive and scientific, and all students have the advantage of being under the personal supervision of some of the best electrical and mechanical experts in the country.

The Electric Light Convention.—The New York Central will provide special accommodations for all those who desire to attend the twenty-first Convention of the National Electric Light Association, to be held in Chicago, Ill., June 7, 8 and 9, 1898. Half the pleasure of attending the convention will be the ride to Chicago over the superb New York Central route. The roadbed is the finest in the world, the dining and sleeping cars are all that can be desired, and the service and all the appointments are perfect. A rate of one fare and a third for the round trip will be granted on the certificate plan

United Correspondence Schools.—The United Correspondence Schools, 154 Fifth Avenue, New York, makes a specialty of its electrical courses, which number seven in all, as follows: Complete electrical engineering, electric station engineering, complete station engineering, electric lighting, electric railway, electro-plating and telegraphy and telephony. As a consequence of the complete manner in which these branches are covered, the number of electrical students enrolled is very large.

Electric Elevators.—Considerable interest is attached to the exhibit of the electric elavator machine for the London Underground Railway, which is to be shown at the Electrical Exposition to be held at Madison Square Garden, commencing May 2. The London machines of this type, which are the largest elevator machines ever built, were made by the Sprague Electric Company. One of the latest electric elevator contracts awarded the Sprague Electric Company is for an outfit of ten machines for the Commerce Realty Building in St. Louis. This is but one of a large number of out-of-town contracts recently awarded the Sprague Company.

Montauk Multiphase Cable.—The Montauk Multiphase Cable Company, 100 Broadway, has received a strong indorsement from the well known Gamewell Fire Alarm Company, which has adopted the multiphase electric cable for use. After a thorough examination of the system, the president of the company informed the owners that the cable is something long known to be desirable, but hitherto considered impracticable, and is a device which the Gamewell Company can safely use for the purpose of combining thermostatic fire alarms with its auxiliary system of connection with public fire alarm telegraph. The weight of this indorsement will be evident when it is considered that the Gamewell Company is the parent of the present fire alarm system, which is used in over 700 of the largest cities in the United States, its apparatus comprising more than 90 per cent of all the fire alarm apparatus used in the United States and Canada.

The Westinghouse Electric and Manufacturing Company has just opened a new branch office at Austin, Texas. Mr. J. E. Johnson will have charge of the office and of the further extension of Westinghouse business in the Southwest. The large contracts which this company has been handling in Mexico and the Texas region have led to the establishment of this new center of electrical trade.

The Burnham-Hall-Chase Company of Boston, report a constant increase of business among surgeons, physicians and dentists for their storage and "Excello" primary battery outfits. These outfits are also highly recommended for running sewing machines and all such work as requires small power. The "Excello" improved gravity battery is well adapted for the work of charging storage cells.

Telephones for the Army.—The Pennsylvania Electric Company of Marietta, Pa., has received a large order for telephones from the War Department to be used for the forts, coast defense and signal stations along the Atlantic coast. The company received instructions to rush the order. This is quite a compliment to the Crescent telephone apparatus, as no doubt all other makes were considered before the order was placed.

Kohler Brothers, Monadnock Block, Chicago, have taken the sales agency for the Northern Electrical Manufacturing Company of Madison, Wis., for the States of Illinois, Iowa, Missouri, Indiana, Nebraska, Kansas, Kentucky, Tennnessee, Michigan, Ohio, Pennsylvania, New Jersey, Maryland, Delaware, and District of Columbia, and are now prepared to figure on all kinds of direct-current electrical apparatus up to 250 kilowatts.

The Ohio Electric Specialty Manufacturing Company, Troy, Ohio, is vigorously pushing the sale of Rogers' lubricant. This lubricant, composed largely of graphite compound, with other first-class lubricating materials, is in stick form, and requires a small amount at each application. This company is also manufacturing a full line of woven wire brushes in all forms and sizes, both lubricating and non-lubricating, and of any desired flexibility.

The Woolverton-Elliott Electric Company has opened an electric repair shop at 442 Niagara Street, Buffalo. Its specialties are armature winding, commutator filling and new armature and commutator building. Special attention is given to overhauling and rebuilding dynamos and motors, and changing from one voltage to another. The members of the firm have had 17 years' practical experience in the above line of work, and can therefore guarantee satisfaction in workmanship, material and price.

Packard Sign Lamp.—Users of miniature incandescent lamps will very readily appreciate the advantage of having a miniature lamp of a standard, reliable make that can be depended upon for efficiency and length of life. The Packard sign lamp, which is a miniature lamp about 2 inches long over all and 1 inch in diameter, fills the demand for a high grade miniature lamp. It is mounted with regular Edison candelabra base, gives about 2 candle power and burns 4 in series on 50 to 60 volts, or 8 in series on 100 to 120 volts. This lamp is carried in stock in Chicago in large quantities by the Electric Appliance Company.

The Q. & C. Company, Western Union Building, Chicago, have acquired the right of sale of the Stanwood step, and it is now known as the Q. & C.-Stanwood steel car step. The Q. & C. Company have recently received a rush order for some 244 complete steps to be used by the United States Naval Department for one of the cruisers being completed at the Norfolk Navy Yard. This company has also furnished this step for the battle ships Iowa, Indiana and Massachusetts, and it is deemed by the United States Naval Department the most efficient step for the service ever manufactured.

Mr. John G. O'Neil, the selling agent for the A. A. Griffing Iron Company, of Jersey City, N. J., located at the Rookery, Chicago, Ill., is meeting with great success in introducing the Bundy steam specialties in that market. A number of his customers express surprise at the excellent results they have experienced, especially in the case of the steam and oil separator. Mr. O'Neil also sells the Bundy feed-water heater, safety water column and exhaust heads. He will be pleased to hear from any one interested in or desiring further information regarding the goods. The A. A. Griffing Iron Company have placed with their selling agent, Mr. George G. Seamans, "U. P." Publication Building, Ninth Street, Pittsburg, Pa., a full line of samples of the Bundy steam specialties. Mr. Seamans has taken up the sale of these goods in the Pittsburg district, and is meeting with good success. He is prepared to answer all communications promptly, and will visit any power plants within reach to make suggestions and estimates looking toward the equipping of the same with Bundy steam and fuel saving devices.

The Filer & Stowell Company, Milwaukee, Wis., has sold to the Worcester & Clinton Street Railway Company, Worcester, Mass., two heavy-duty engines; one of 600 h.p. jet condenser, and one of 600 h.p. heater. It is also building a 500-h.p. tandem compound to be direct-connected to generator for the Bluff City Electric Railway Company, of Chicago, and a 300-h.p. tandem-compound engine, also for street railway work, for the Warren Electric Light Company, Warren, Pa. All of the above engines are of heavy-duty type, with Filer & Stowell Company's latest pattern, or 1900 style, heavy-duty frame. A 500-h.p. cross-compound heavy-duty engine with surface condenser is now being erected for the electric light plant in the city of Jacksonville, Fla.; two single cylinder engines in the electric plant in the city of Donalsonville, La.; a 24 x 48-in. Corliss engine for plant of the Home Electric Company, Baton Rouge, La., and a 14 x 30-in. for electric light and water-works plant at City of West Point, Miss., will soon be shipped. A 24 x 42-in. Corliss has just been started in the elevator of

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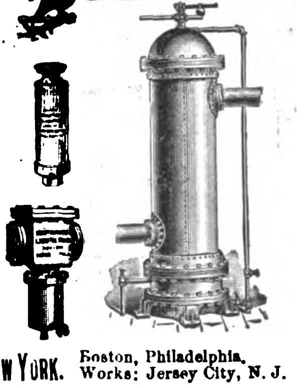
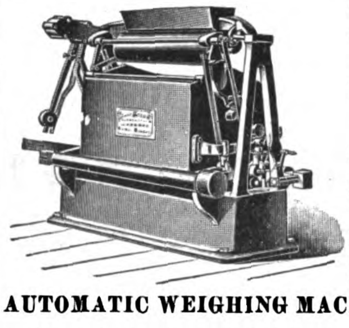


the Export Elevator Company, Buffalo, N. Y. This makes the third engine which the Filer & Stowell Company have furnished to these people within two years. They are now building a 500-h.p. cross compound for the Kimberly & Clark Company, who are large paper manufacturers at Neenah, Kimberly and Appleton, Wis. The Filer & Stowell Company take just pride in having received this order from the Kimberly & Clark Company, who have been using two engines of their make for about three years, and at the same time have been using for a number of years past as many as 12 engines of another prominent manufacture.

Electrical Exhibition.—One of the most interesting exhibits in the May Electrical Exhibition at Madison Square Garden will probably be that made by the C. & C. Electric Company of New York. In the basement of the building, where the operative exhibits will be placed, there will be shown a C. & C. multipolar generator directly connected to a 25 h.p. Diesel "Rational Heat Motor," a new type of engine which has created such a stir recently in the engineering field of both Europe and America. On the main floor of the building the C. & C. Company will have an exhibit occupying 500 square feet of floor space, in which will be shown all their latest types of machines, including their well-known types of bipolar dynamos and motors in several sizes; also quite a full line of their now celebrated closed type ironclad motors and dynamos. These machines of the Ironclad type will be shown, some separately and some in combination with other machinery. The 20 h.p. inclosed ironclad motor will be shown mounted in connection with a Lambert hoist and one of the dynamos directly connected to a Case engine. The exhibit will also include one of the ironclads fitted up with back gears for speed reduction. Two of the company's slow speed belt types generators will be exhibited, and numerous other interesting machines, appliances and parts will be also shown. A C. & C. switchboard will form an attractive feature of each exhibit.



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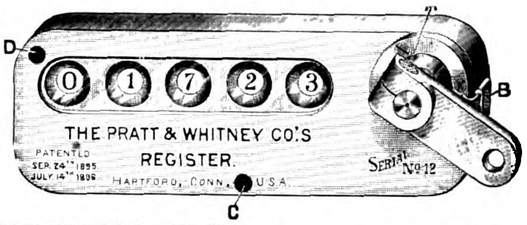

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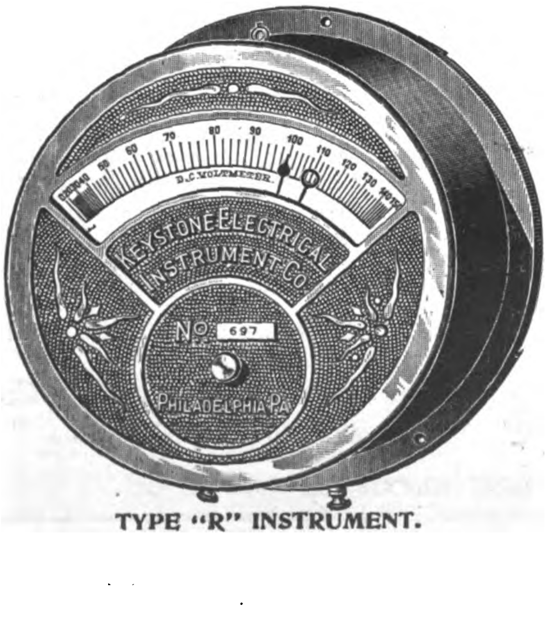

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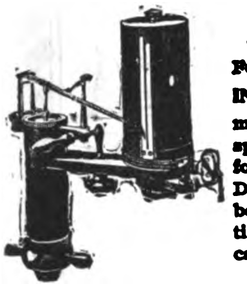

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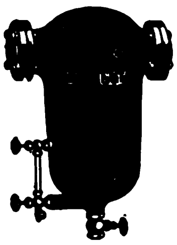

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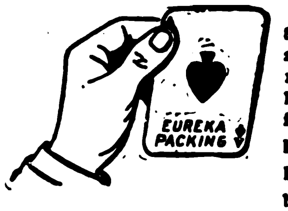

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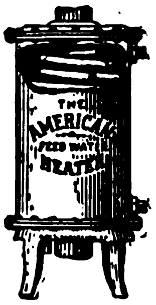
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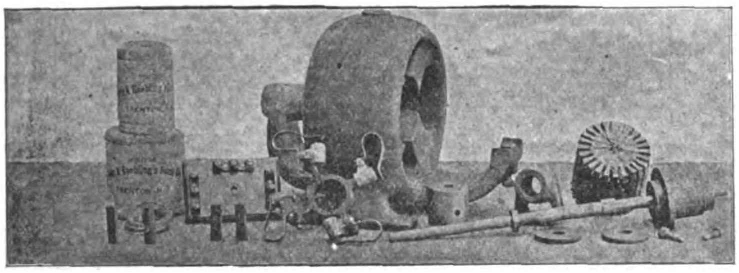

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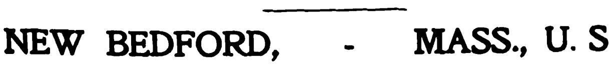

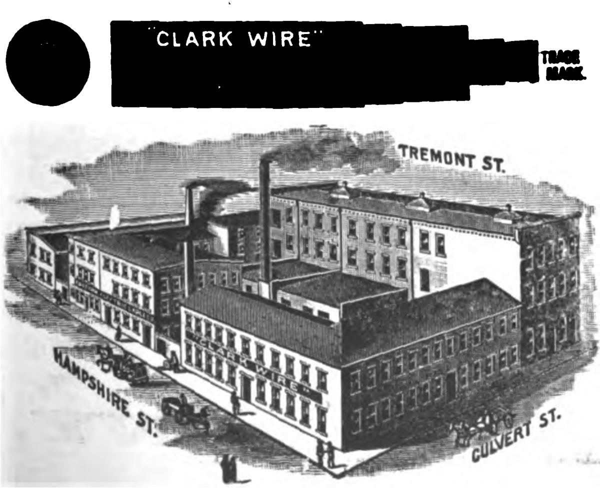
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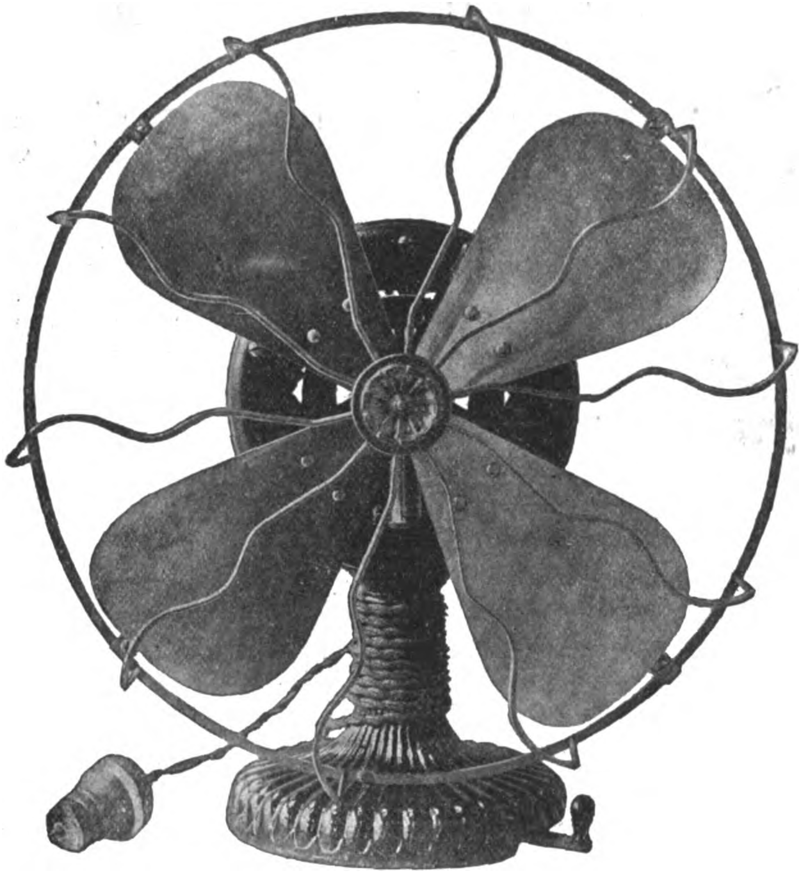

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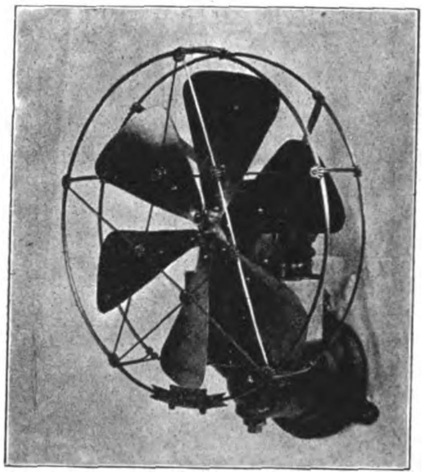

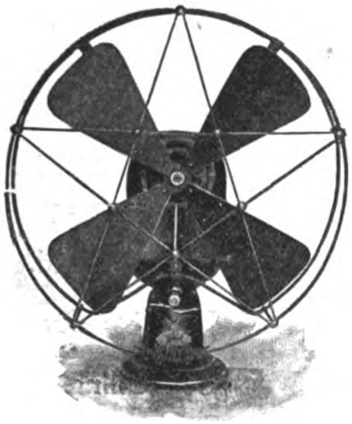

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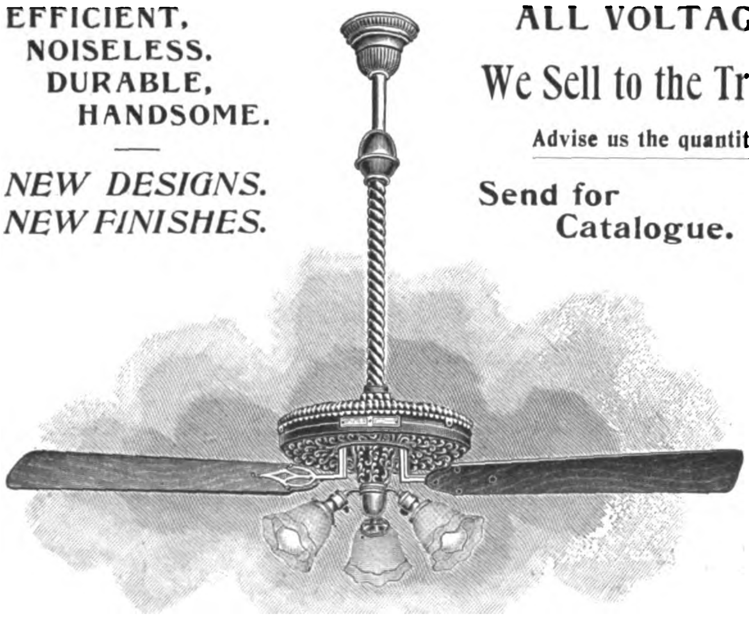

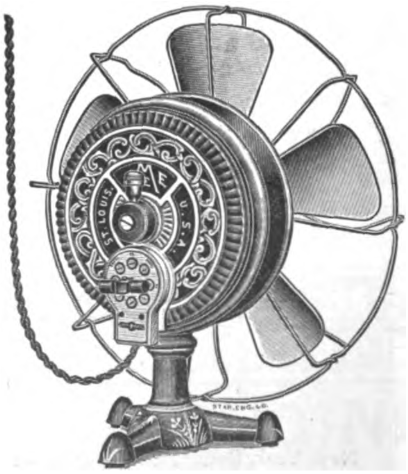

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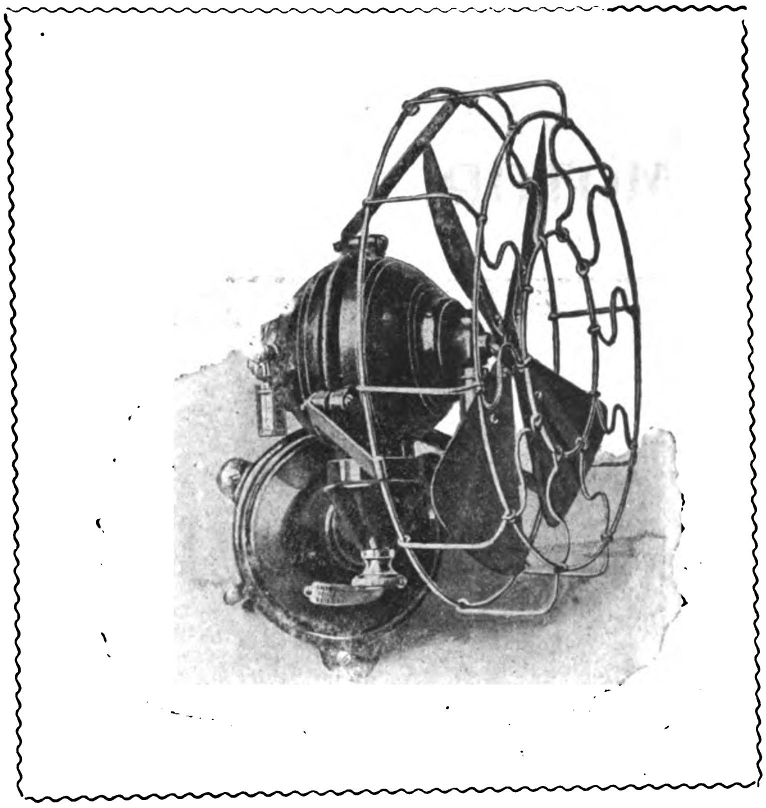

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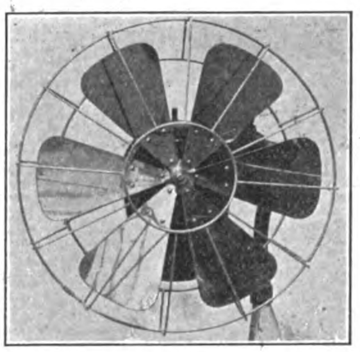

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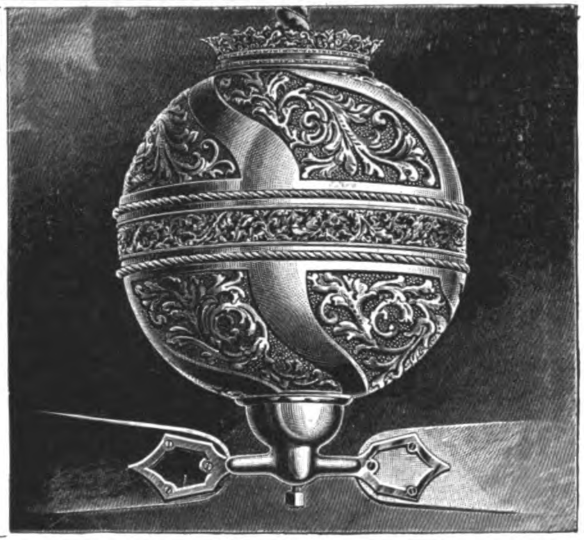

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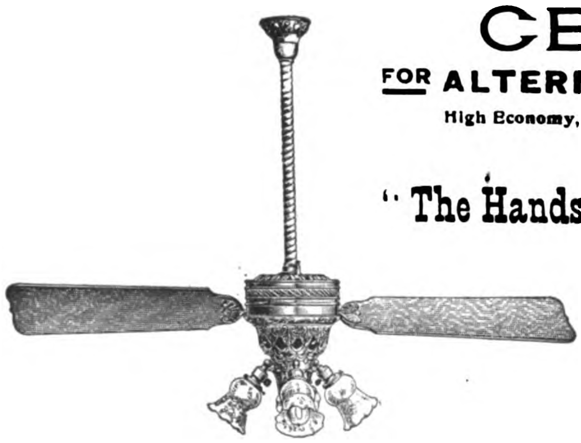

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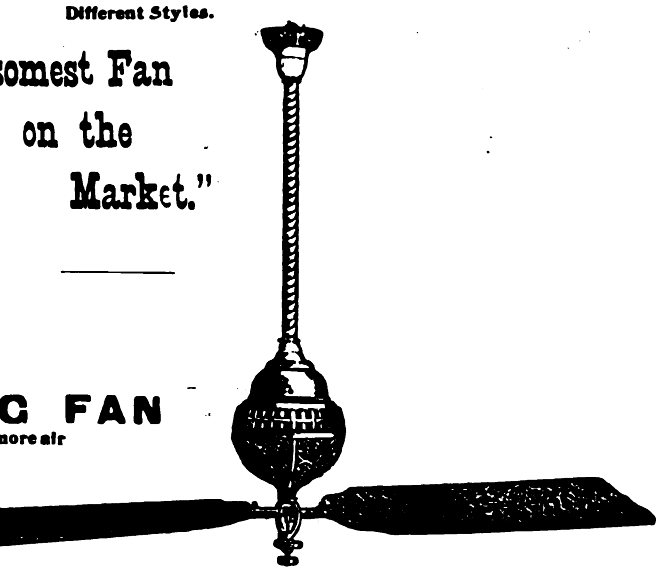

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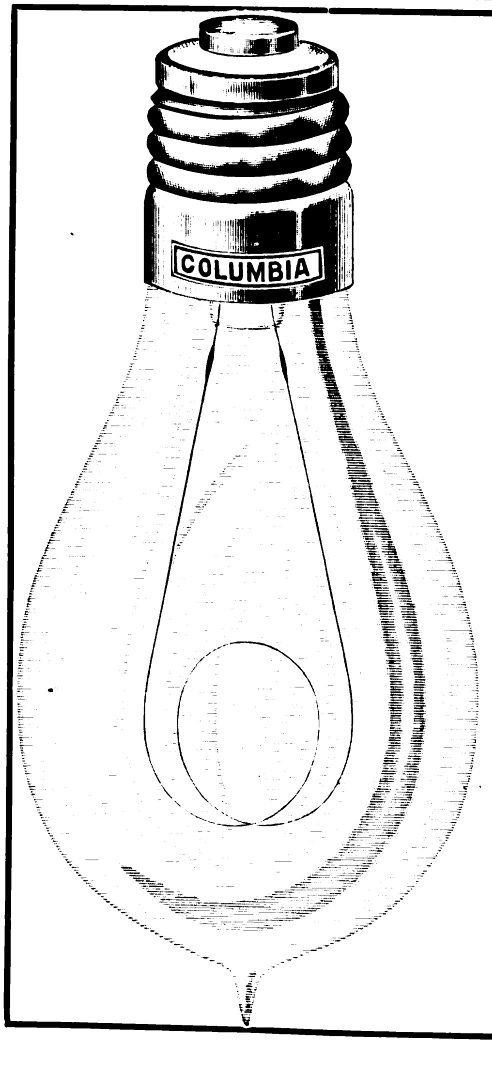

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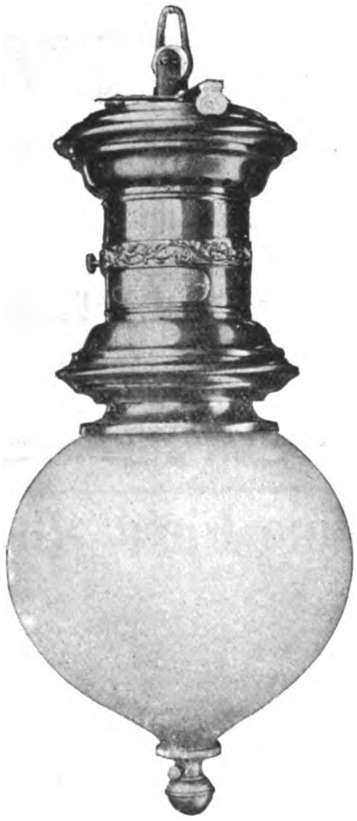

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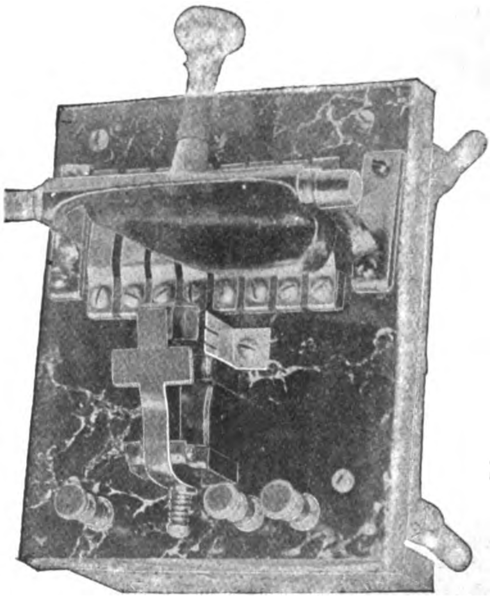

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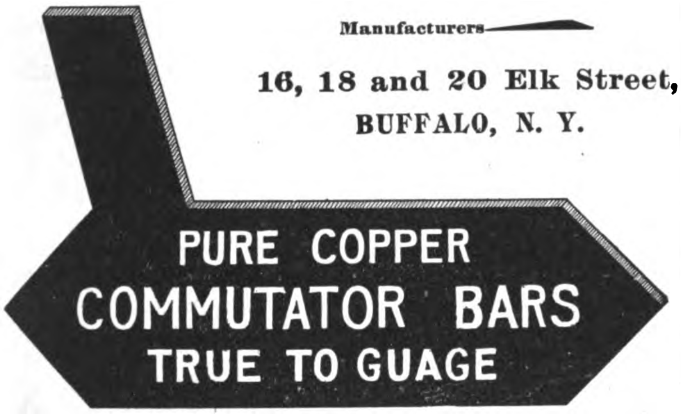

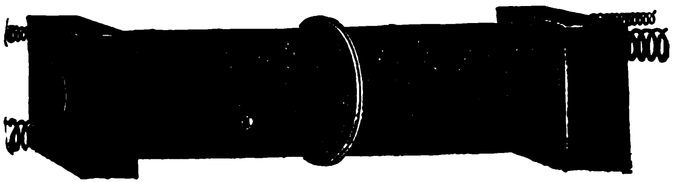

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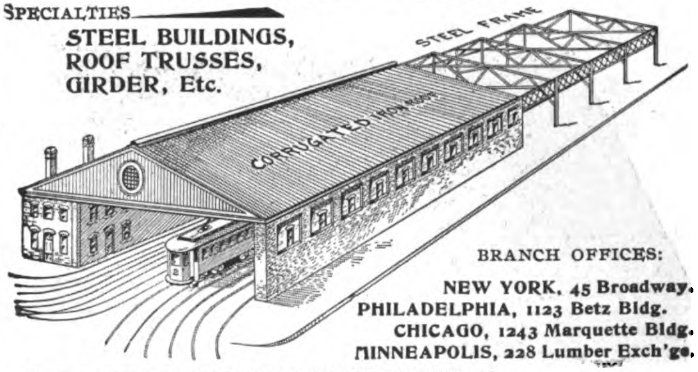

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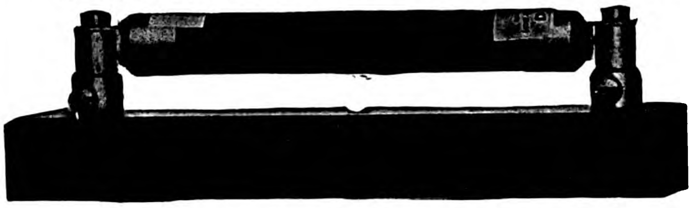

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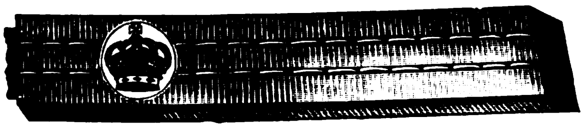

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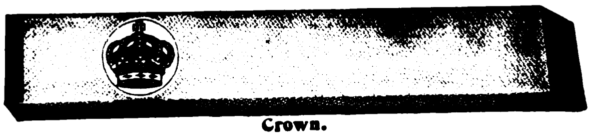

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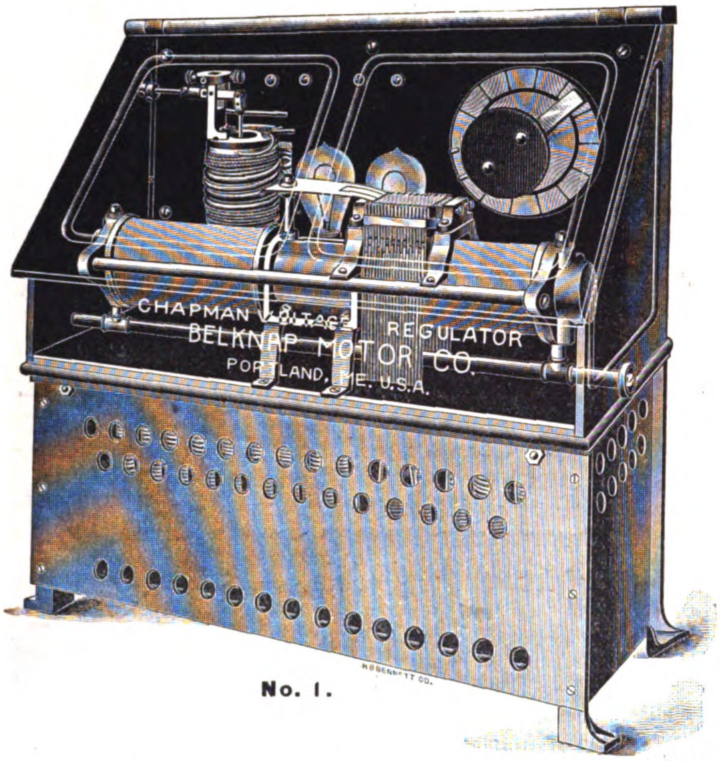
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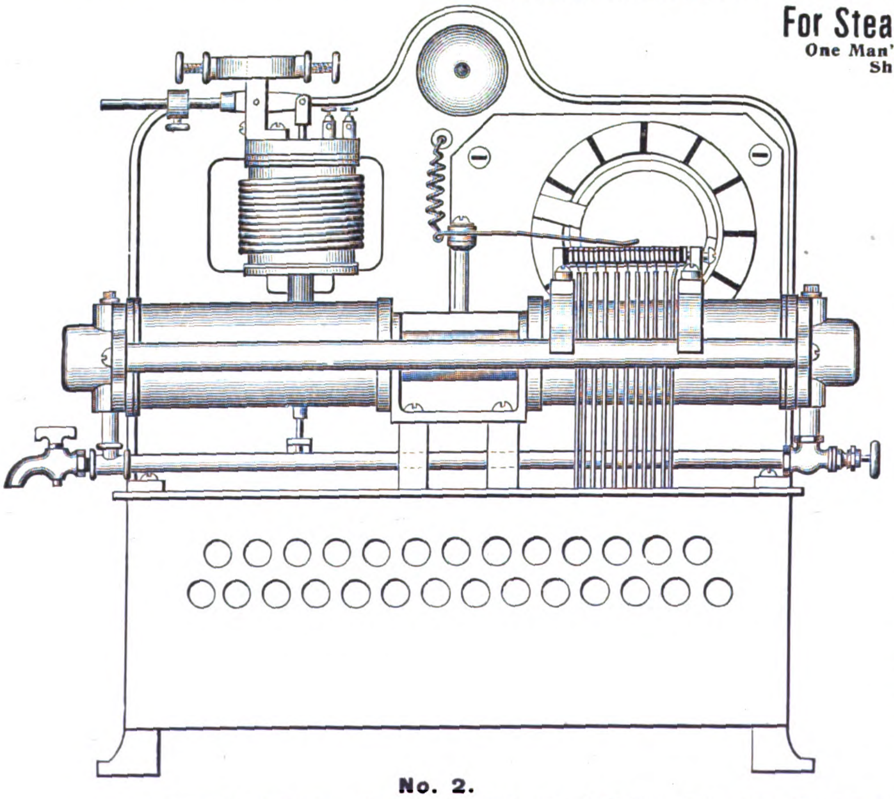

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E. B. NEWCOMB, General Manager.

What the Edison Electric Illuminating Co. say:

TOPEKA, KAS., Oct. 27, 1897.

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As I say, we are well pleased with the regulators and could not be without them now we know their worth. Yours very truly,

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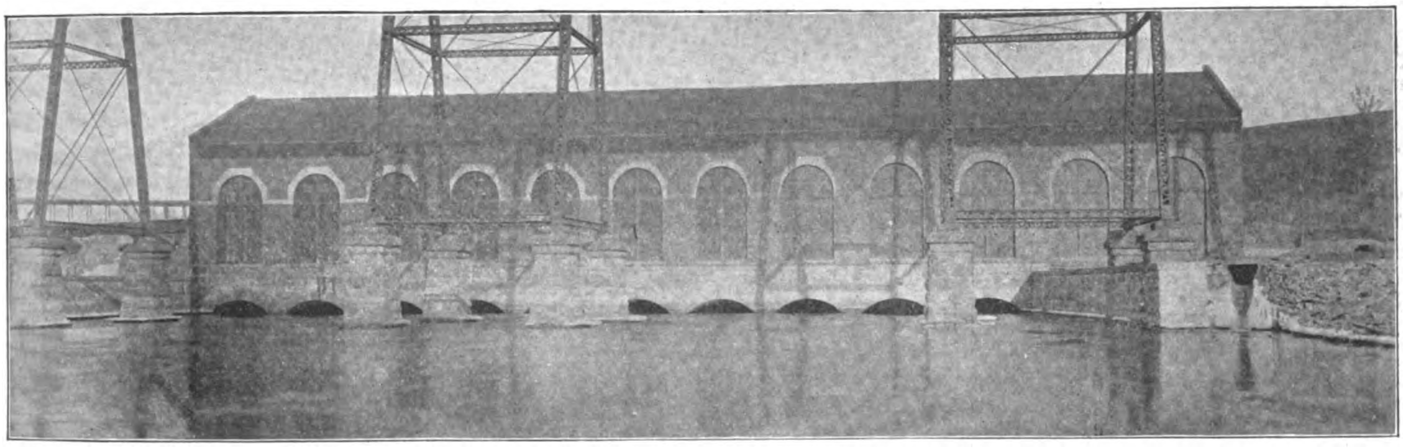

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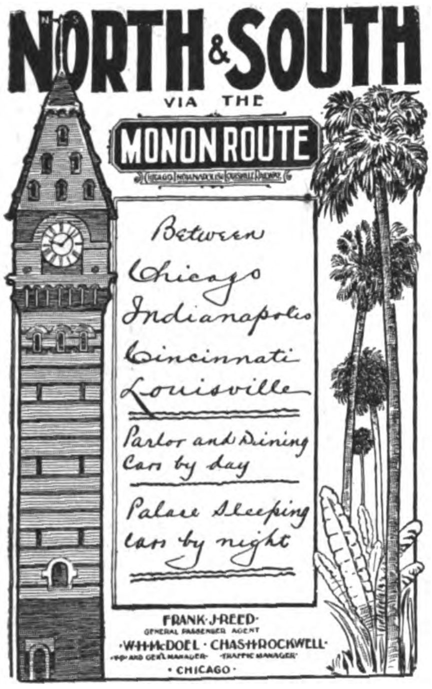

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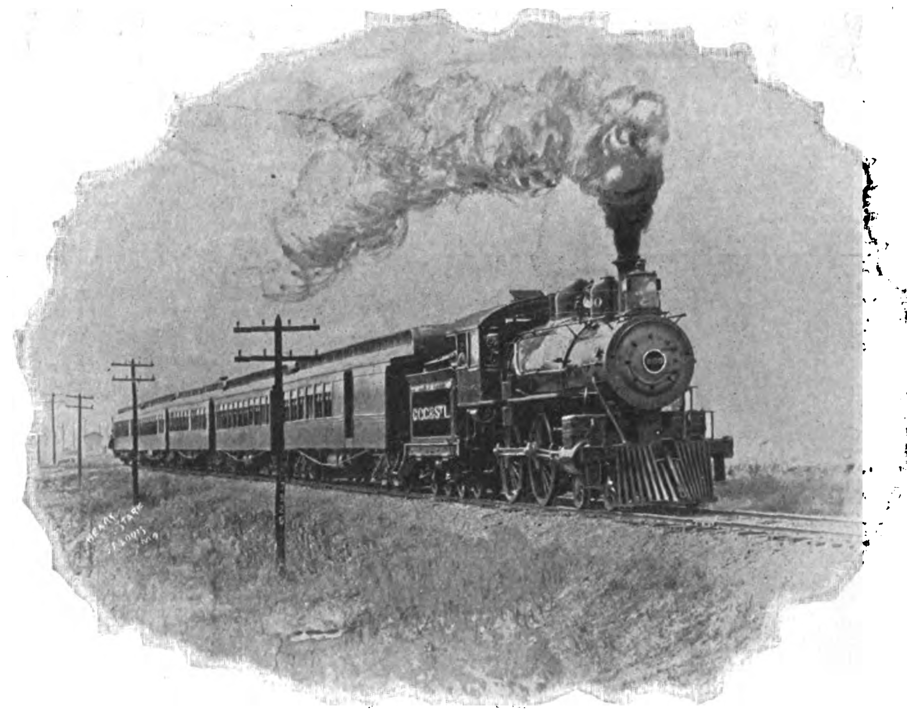

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American Electrician.

Vol. X. New York, June, 1898. No. 6.

A GAS ENGINE CENTRAL STATION.

AN INTERESTING POWER PLANT.

BY J. J. FLATHER.

A few years ago the gas engine was known, at least in this country, principally as a motor for small powers, and on account of its irregularity it was deemed unsuitable for operating electrical machinery; but the great economy of the gas engine has led to its introduction in larger sizes, so that to-day engines having a capacity of 750 h.p., are in operation, and larger ones are being contemplated.

With the increase in size, better methods of regulation have been introduced, and their use as a motive power in isolated lighting stations has for some time been an assured success—not only from a mechanical standpoint, but from the commercial side of the problem. Their operation is as smooth and reliable as steam engines under the same conditions, and an economy has been attained showing a consumption of only 10 cubic ft. of gas per h.p. per hour.

The advantages of using gas engines for dynamo driving have been enumerated, as follows: *

"1. Small amount of space required. 2. Small consumption of water—5 to 6 gals. per h.p. hour, or less. 3. No coal to carry; independent of railway station. 4. No smoke. 5. No explosions. 6. Cheaper than steam engines in respect to (1) ground required; (2) relative convenience of gas motors rather than steam engines in a town, whence greater choice of place within a town, and smaller distances to lay cables; (3) gas engines above 100 h.p. being cheaper than steam engines, boilers and chimney. 7. Less loss of electricity, because station more favorably situated. 8. Less attendance and wages. 9. Exact control over fuel."

Where gas engines have been used in isolated electric lighting stations it has been frequently demonstrated that twice as much light can be furnished from a given amount of gas if used in the gas engine than could be obtained from the same

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* German Imperial Gas Association, Dessau.

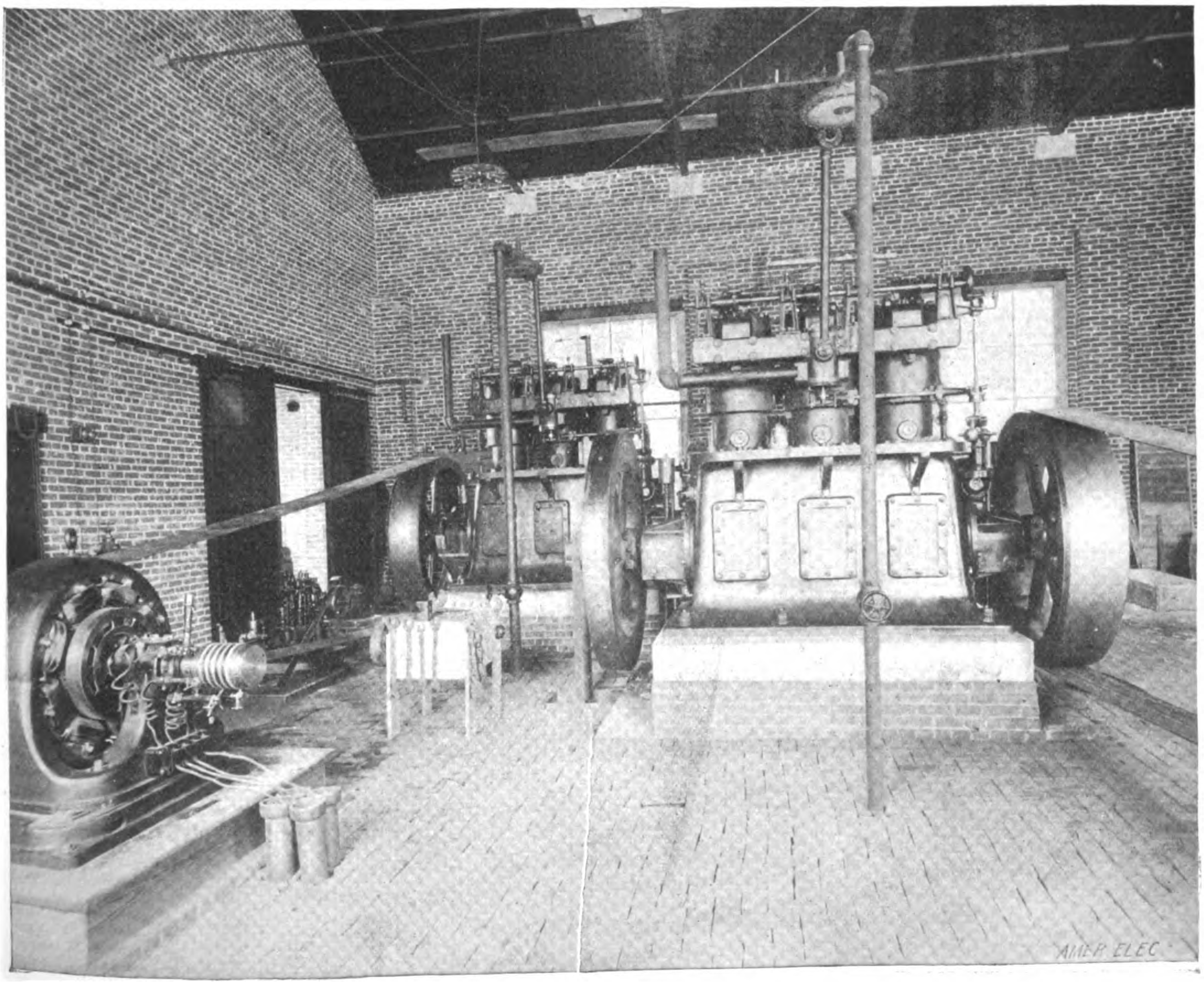


FIG. 1.—INTERIOR VIEW OF STATION.

quantity of gas if burned in the usual way. It has also been repeatedly shown that, even with small engines, the economy of fuel consumption is much greater if the fuel be first converted into gas and used with a certain per cent of air as an explosive mixture in the cylinder of a gas engine. Thus one pound of coal will generate sufficient gas to furnish 1 h.p. hour for a small gas engine.

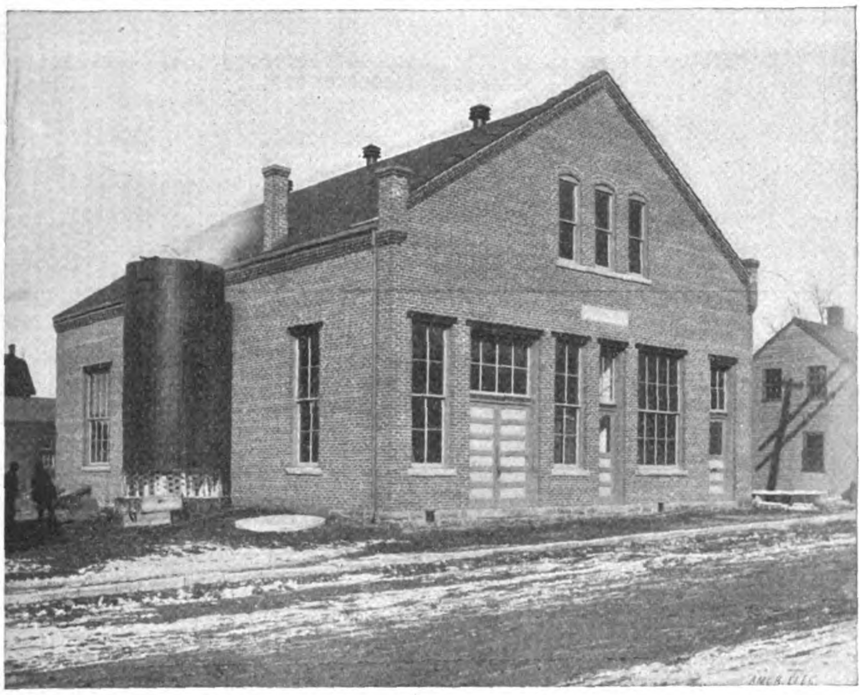


FIG. 2.—EXTERIOR VIEW OF PLANT, SHOWING COOLING TOWER.

The most economical triple expansion steam engines cannot equal this, and, ordinarily, a large steam engine requires about twice as much fuel, while a small steam engine of the same capacity as the gas engine may require from 5 to 10 times as much.

The introduction of the gas engine in larger sizes will undoubtedly be greatly increased, as the means for producing a cheap fuel gas become more extended.

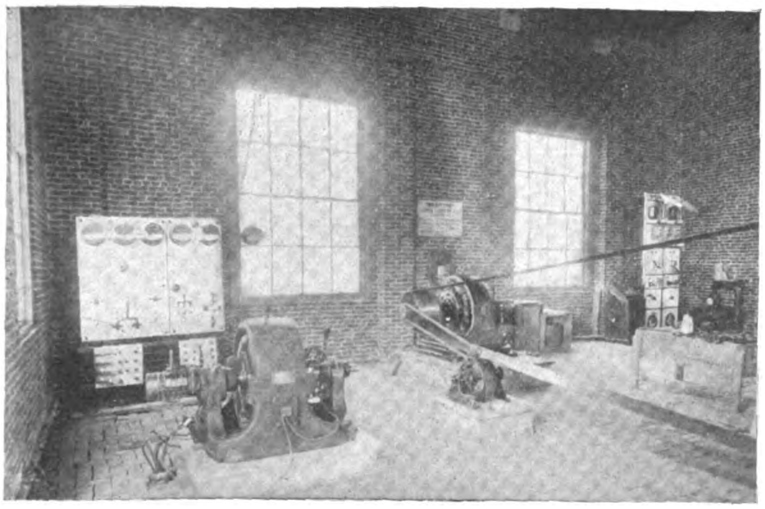


FIG. 3.—INTERIOR VIEW, SHOWING ROTARY TRANSFORMER AND SWITCHBOARD.

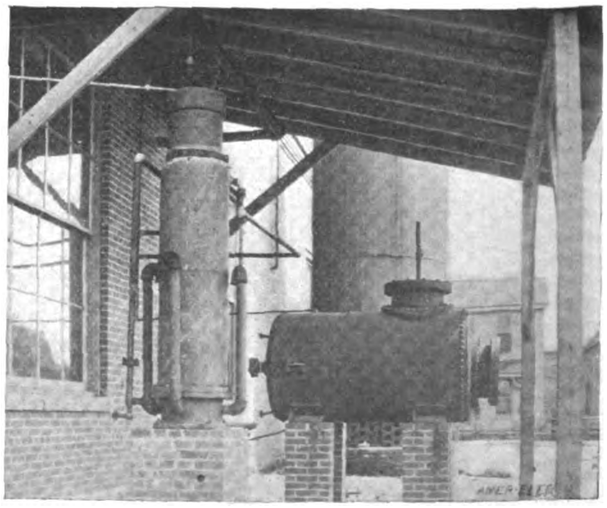


FIG. 4.—GASOLINE TANK, CARBURETOR AND COOLING TOWER.

The possibility of obtaining a higher theoretical efficiency in the conversion of heat energy into mechanical energy through the medium of gas or heat engines is a factor of much importance in the further development of the gas engine.

In the natural gas regions of Ohio and Indiana a gas of high calorific intensity can be obtained for a few cents per 1000 cubic ft., and under these favorable conditions the economy of operation becomes very marked.

An interesting installation, involving the most modern practice in gas engine construction and operation, has recently been erected at Lafayette, Ind., by the Merchants' Electric Association, which illustrates to a remarkable extent the economy obtainable under favorable conditions.

The plant was erected under the direction of Mr. C. C. Chappelle, manager of the company, and the results achieved fully indorse the means employed. Mr. Chappelle states that since the change from steam to gas engines the cost of fuel for operating a given number of lamps is only 22 per cent of that which formerly obtained. The plant is located in a fireproof brick building, 45 ft. x 60 ft., as shown in Figs. 1, 2, 3, 4 and 5, which latter also indicates the position of the various machines. At present a temporary brick floor is used, but it is the intention to place a cement floor in the building as soon as the present filling settles.

The plant was designed for three units, each consisting of a 125 h.p. gas engine, belted to a 60 k.w. dynamo, two of which units are now in operation.

The present electrical equipment consists of two 60 k.w. Westinghouse 2-phase dynamos, 7200 a.p.m., 2000 volts, running at 900 r.p.m., which were installed upon a guaranteed capacity of 25 per cent overload with a heat limit of 50 deg. C.

These dynamos furnish current for about 40 inclosed alternating arc and 1000 incandescent lamps, besides running a 50 h.p. Westinghouse rotary transformer for direct current motors. The current is controlled by a Stillwell regulator, and is transmitted at a potential of about 2100 volts, which is reduced by a service transformer, of 100 and 200 light capacity, to 104 volts in the secondary.

The 4-pole rotary transformer which furnishes direct current at 500 volts for the power circuit, runs at 1800 r.p.m. The motor end of the machine is operated as a 2-phase induction motor, which receives its current from a pair of oil converters at a potential of 400 volts. The power circuit is arranged as a three-wire system for 500 to 250 volts, the neutral wire being connected to the middle of the secondary from each of the two converters, to balance the line.

The method of starting this machine presents some interesting features. At first it was proposed to use a choke coil as a regulator, but this was abandoned and the present method was introduced which involves bringing the motor into synchronism by starting with a greatly reduced voltage and gradually increasing by successively changing the plug connections at the switchboard by means of two 4-pole switches—the secondary on the transformers being suitably divided into sections and connected to the switchboard to permit this. In bringing up the rotary to synchronism by this method of starting, the maximum current is about 40 amps. at 2000 volts, but the power factor is very small, and maximum current only exists during a period of 1½ to 2½ mins., after which time the machine gets in step and the current is immediately reduced.

The motive power equipment is very complete, and may be regarded as a model of its kind. The gas engines were built by the Westinghouse Machine Company, and erected upon a guarantee to deliver 125 brake h.p. with a consumption of from 13½ to 14 cu. ft. of gas per brake h.p. per hour—the gas to contain as many heat units per cubic foot as the Pittsburgh natural gas. These engines are 13 ins. diameter of cylinder by 14 ins. stroke, and run at 265 r.p.m.; they are piped for both natural and artificial gas, since in very cold weather the natural gas supply is liable to be shut off from all manufacturing firms in the city. The two engines installed at Lafayette are shown in Figs. 1, 10 and 11.

In addition to this a gasoline tank and carburetor have recently been erected outside the building, as shown in one of the views, and the engines piped so that either or both may be run on gasoline.

In order to use gasoline vapor, a slight change is necessary, since the high compression carried at full load would probably produce a sufficient amount of heat in the cylinder to cause premature explosion of the charge. This is obviated by placing an extra bonnet upon the top of the cylinder, which thereby enlarges the clearance volume and reduces the compression.

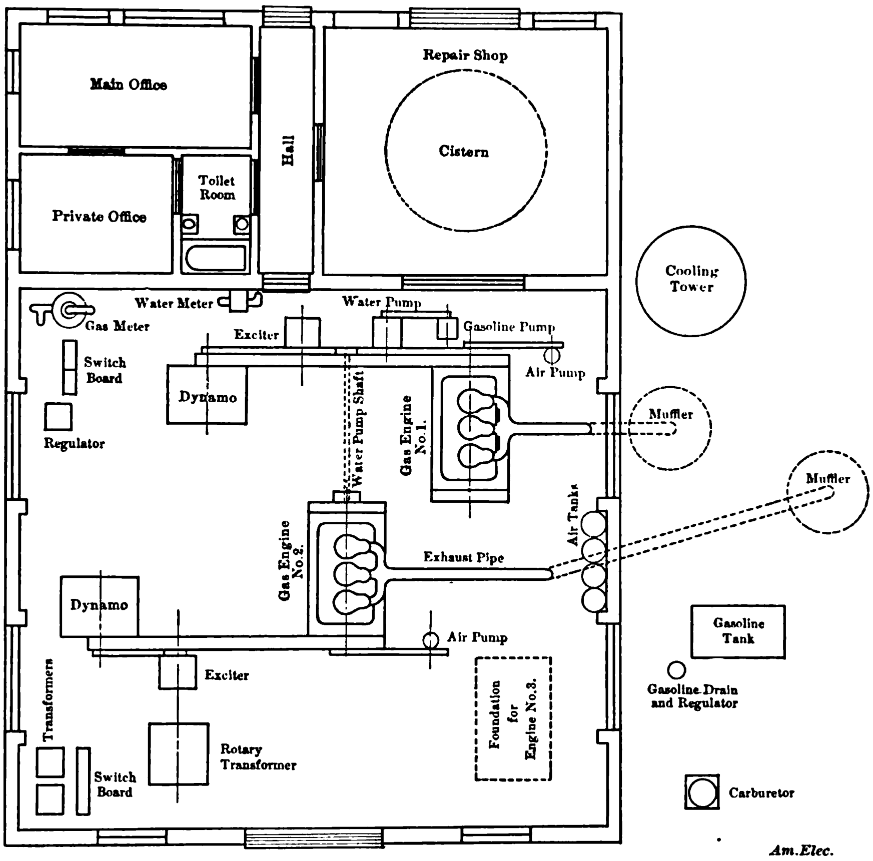

Main Office
Hall
Repair Shop
Cistern
Toilet Room
Private Office
Cooling Tower
Water Meter
Water Pump
Gas Meter
Exciter
Gasoline Pump
Switch Board
Air Pump
Dynamo
Water Pump Shaft
Gas Engine No. 1.
Muffler
Regulator
Muffler
Air Tanks
Gas Engine No. 2.
Exhaust Pipe
Dynamo
Air Pump
Gasoline Tank
Exciter
Gasoline Drain and Regulator
Transformers
Foundation for Engine No. 3.
Rotary Transformer
Switch Board
Carburetor
Am. Elec.

FIG. 5.—PLAN OF STATION.

The cooling water for the jackets is obtained from a 12 ft. cistern, located beneath the floor of the repair shop in the front of the building, although city water may be used independently if desired; the water is heated to about 180 deg. F. in passing through the jackets, and is cooled by evaporation in air currents as it passes down through a series of drain tiles placed in a cooling tower, as shown in Fig. 6.

There is a marked advantage in using the same water continuously, since incrustation in the jackets and pipes is thereby reduced to a minimum. Where water is used containing much carbonate of lime in solution, the temperature of the jackets will have to be reduced unless the lime is precipitated or neutralized with soda or other agent; even then much trouble may be experienced. In the present case only a small amount of scale is formed, and this is largely produced by the use of city water, which is necessary to supply the loss due to evaporation.

A 3-throw water circulating pump is belted either directly from one engine, or from an underground shaft driven from the other engine, as shown at the right in Fig. 1. The quantity of cooling water used by each engine varies from 4 to 5 gals. per h.p. hour.

Each engine is belted to a small air pump, which is used for charging 4 air tanks with a supply of compressed air for starting the engines. These tanks each contain about 7 cubic ft. of air, which is maintained at a pressure of 160 lbs. per sq. in.

The air pump shown in foreground, Fig. 1, can be operated by hand to charge the tanks for the first time, after which they are run by a belt from the engine a short

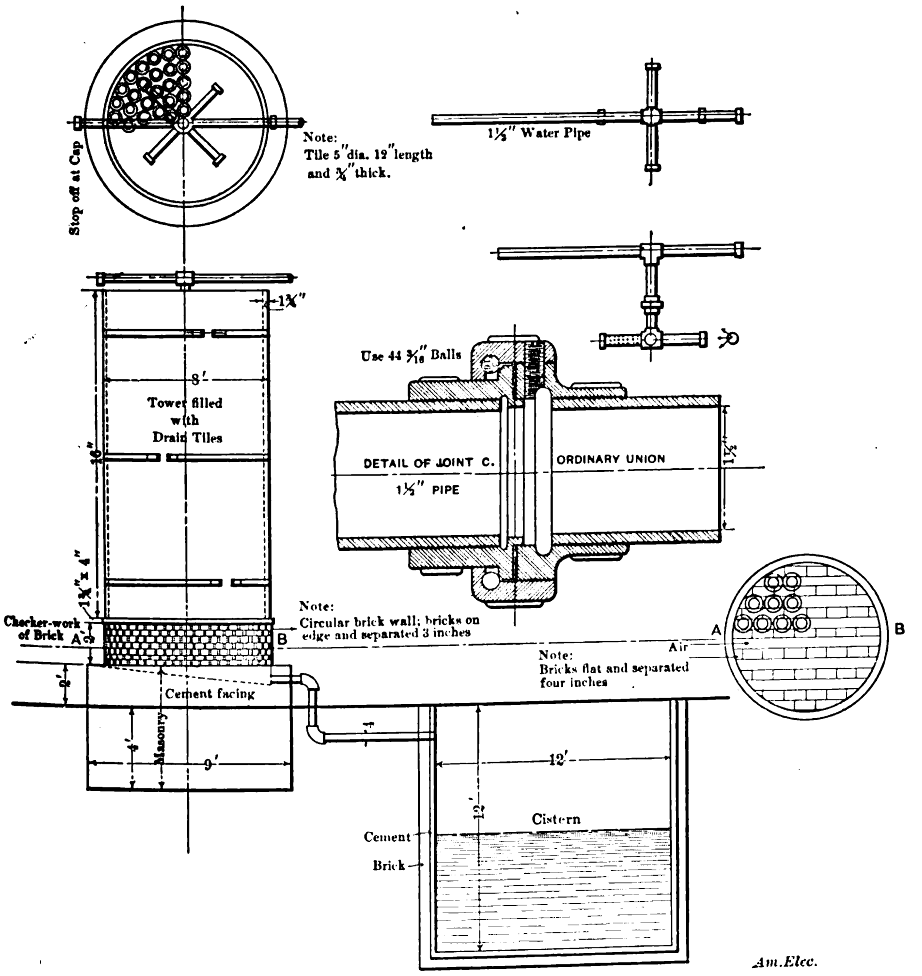

Stop off at Cap
Note: Tile 5" dia. 12" length and ⅜" thick.
1½" Water Pipe
1¼"
8'
Tower filled with Drain Tiles
16'
Use 44 5/16" Balls
DETAIL OF JOINT C.
1½" PIPE
ORDINARY UNION
1½"
1¼" x 4"
Checker-work of Brick
A
B
Note: Circular brick wall; bricks on edge and separated 3 inches
A
B
Air
Note: Bricks flat and separated four inches
2'
Cement facing
Masonry
4'
9'
12'
12'
Cistern
Cement
Brick
Am. Elec.

FIG. 6.—DETAILS OF COOLING TOWER.

time each day to restore the pressure after starting the engine.

A pipe leads from these storage tanks to one cylinder of each engine, in which pipe a valve is arranged to be opened and closed at each revolution of the engine by means of a cam on the end of the shaft which operates the exhaust valves, the opening occurring just as the crank is passing its upper centre. By throwing a lever on the crank case to the rear the exhaust valve on this cylinder is set so that it opens on every return stroke of the piston, instead of every other stroke, as when the engine is in normal operation.

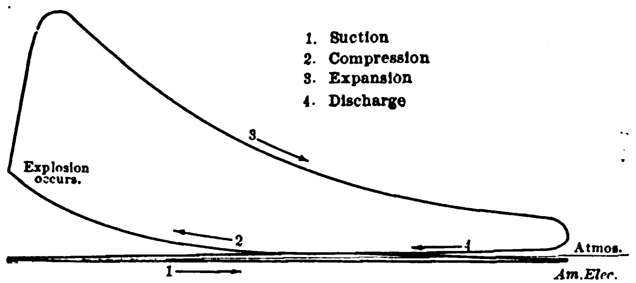
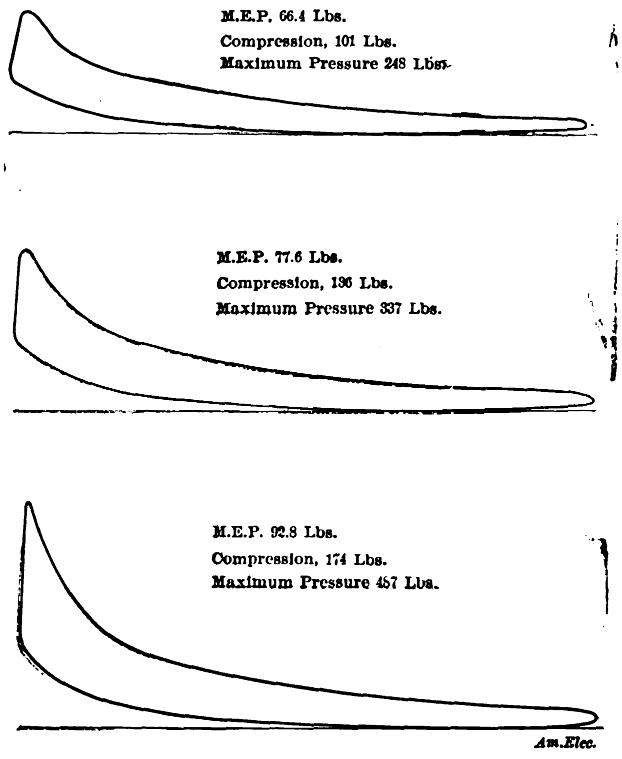


FIG. 7.—STARTING CARD.



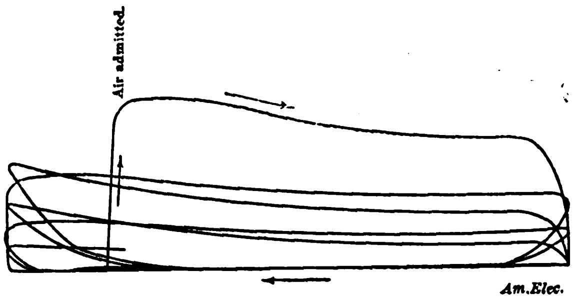


FIG. 8.—TYPICAL GAS ENGINE CARD, OTTO-CYCLE.

FIG. 9.—GAS ENGINE CARDS.

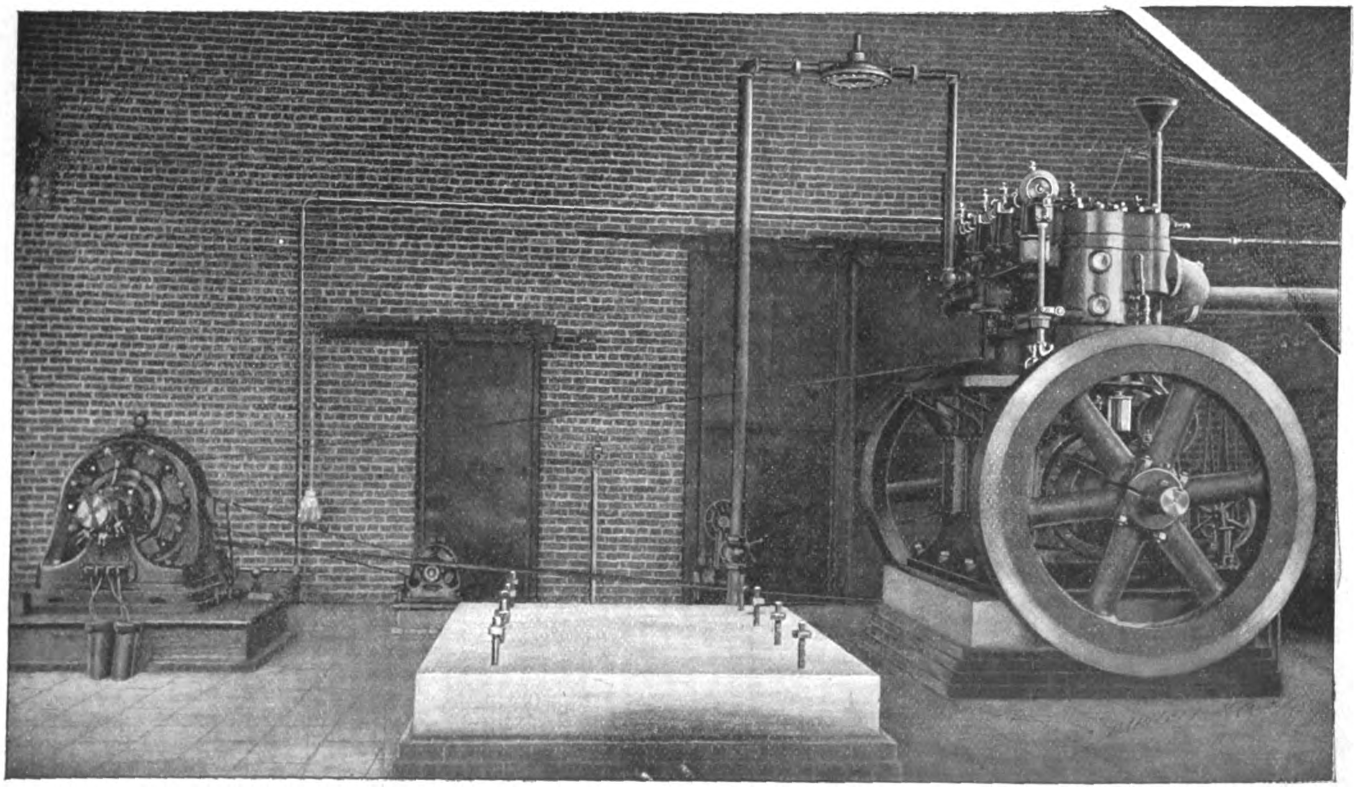


FIG. 10.—INTERIOR OF STATION, SHOWING ONE ENGINE.

A knurled thumb screw on the end of the cam shaft disengages the admission valve cam for this cylinder, and throws the valve out of operation. It will readily be seen that one cylinder of the engine is now converted into a compressed air motor, without in any way disturbing the functions of the other two cylinders. The engine being set with the cranks about 45 deg. beyond the top center, the air and gas inlet valves properly adjusted, and the stop valve on the compressed air tank opened, it starts up and continues to run on the air pressure until explosion takes place in the other cylinders; the stop valve is then closed, the inlet and exhaust valves are brought into normal position again, and explosion follows in this cylinder, as in the others. The operation is entirely automatic, and is extremely simple, as 3 or 4 revolutions with the air pressure are

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generally sufficient to start the engine. Fig. 7 is reproduced from an indicator card, taken while starting the engine, and shows very clearly the pressures inside the cylinder.

The engines operate on the plan proposed by M. Beau de Rochas, popularly known as the "Otto cycle," in which the combustion is assumed to take place at constant volume.

On the first outward stroke, Fig. 10, the piston draws in a charge of the explosive mixture, which it compresses on the return stroke; as the crank passes the center the charge is ignited, and expansion takes place on the next forward or working stroke. During the succeeding return stroke the burnt gases are expelled, leaving the cylinder ready to repeat in regular order the same series of operations or cycle.

The single-acting piston receives in consequence only one impulse for each four strokes, or each two revolutions of the crank. This feature places the single cylinder engine somewhat at a disadvantage in the matter of steady rotative speed, which may be still further aggravated by the hit and miss system of governing in which the regulation is effected by varying the frequency of explosions leaving the intensity the same.

This method is not particularly well adapted to the exacting requirements of electric lighting, especially with the increased use of high efficiency lamps, although it produces very satisfactory results when running under conditions where some variation in speed is permissible.

In any case, the regulations may be improved by the use of suitable flywheels on the engine shaft or on the shaft of the dynamo, or both; but even with the greatest precautions the explosions in the engine can often be counted by the changing brilliancy of the lamps in circuit, and always by fluctuations shown by a sensitive voltmeter.

A better method of regulation is that obtained by the use of two or more cylinders by which more frequent impulse is given to the shaft. In the present case three cylinders are used, and the regulation is obtained by throttling the charge, which is a constant mixture—a lesser or greater amount of the mixture being admitted to the cylinder, depending upon the load.

The cranks are set at 120° and an impulse is received every two-thirds of a revolution, whether the engine be fully loaded or not. As will be noticed from the cards (Fig. 9) the compression at light loads is correspondingly less than at heavy loads, and it has been argued that the efficiency of the engine is thereby impaired. It is undoubtedly true that the efficiency is less at light loads than at full load, but this objection can be urged with equal force against any source of power, be it steam engine, gas engine, electric motor or water wheel.

The absence of reliable data on the subject makes the question as to whether the falling off in efficiency at light loads is more rapid in the engine which keeps the number of explosions constant and adjusts the charge, than in the engine which regulates by the frequency of its explosions, a matter of conjecture. The superior running qualities of the former, and its peculiar adaptability for electric lighting and other purposes where nicety of regulation is essential, will undoubtedly overcome any objection to the principle involved, since the closeness of regulation more than compensates for any loss of theoretical efficiency.

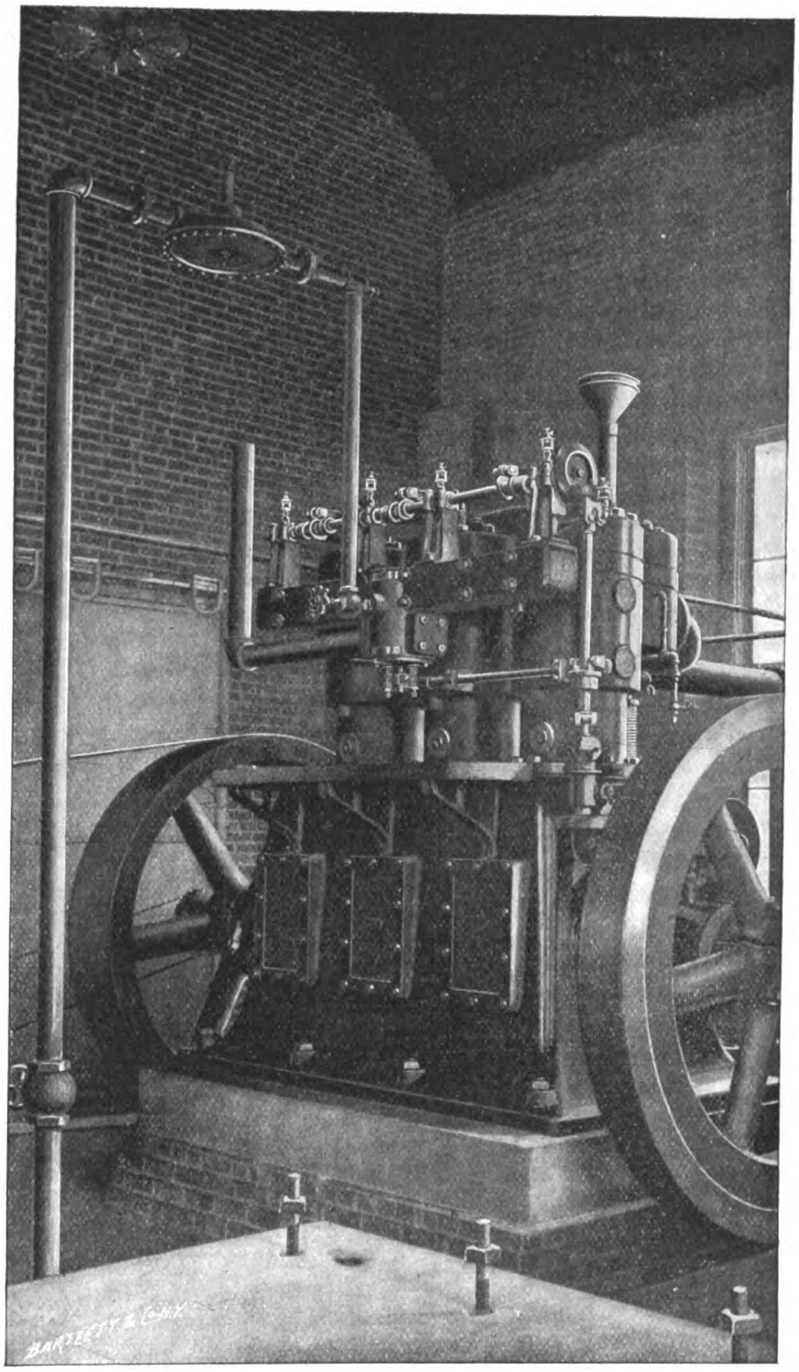

FIG. 11.—ONE OF THE GAS ENGINES.

With natural gas at 7 cents per 1000 cubic ft., the cost of power in gas engines is but a fraction of that obtained by the use of a steam engine, even where the gas is used as fuel for the boilers. In numerous tests made by the writer on various gas engines in Lafayette and vicinity, it was conclusively shown that the fuel cost was less than one-sixth of a cent per h.p. hour.

Chemical analysis and meter tests show that the Indiana natural gas is very rich in hydro-carbons and yields upward of 1050 heat units per cubic ft. This gas may be diluted with from 12 to 14 times its volume of air in order to obtain a suitable explosive mixture.

On the other hand, the artificial or illuminating gas has a much lower heat energy and requires a lesser quantity of air for dilution, the amount being about 10 cu. ft. of air per ft. of gas. Thus illuminating gas not only costs more per 1000 cubic ft., but a greater quantity is required to generate a given quantity of power.

◆

Gas Explosion Temperatures.

From some experiments made in England on gas explosions at constant volume, it was computed that the temperatures ranged from 1483 degs. Fahr. for 1.14 mixture of gas and air, to 3293 degs. for a 1.5 mixture.

A STORAGE BATTERY CENTRAL STATION.

THE CLAREMONT ELECTRIC LIGHT SYSTEM.

BY F. B. SAGE.

The Claremont Electric light plant of Claremont, N. H., is one of the most unique of its kind in this country, and is exceptionally interesting because it conclusively exemplifies the advantage of the application of storage batteries to small lighting installations. The plant is located on the south bank of the Sugar River, from which it obtains power, a head of 15 ft. being available. A general view of the building and dam is shown in Fig. 3. The building is constructed with stone sides and wooden flooring. It was originally a portion of the adjacent rubber factory, and has been adapted to the requirements of the installation it now contains.

The Sugar River has its origin in Lake Surripee, about 18 miles from Claremont, and supplies power for numerous factories and machine shops. At the Claremont plant there is a dam 250 ft. long and 15 ft. high, backing the water up for a mile and a half. During the day the rubber factory and two large shoe factories draw power from this source, and at night the power is utilized by the Electric Light Company. The maximum head is 16½ feet and the minimum 7½ feet.

The wheel pit is bulit of 2-in. chestnut planks nailed to substantial uprights extending between floor beams. It empties into a stone tail race which runs parallel to the north wall for its entire length and opens into the river below. The main floor is divided into three rooms. The dynamo room is the largest, and occupies two-thirds of the length of the building and its entire width. The remainder is divided into two rooms, the larger of which contains the battery plant and the smaller provides office accommodations. In addition to the main floor there are two extensions, one of which contains an auxiliary engine which is used at seasons of low water, and the other is divided into two parts, a repair shop and wagon shed.

The turbine was supplied by the Hunt Turbine Company, of Orange, Mass. It operates under an average head of 15 ft. and drives the horizontal main shaft at a speed of 70 r.p.m., being connected to the latter by the usual bevel gears. Water is supplied to the wheel by two diametrically opposite gates in the casing. These are controlled by hand wheels conveniently located near the dynamos. No automatic governor is used, the speed being entirely regulated by the storage batteries, as will be explained beyond.

The main shaft runs the entire length of the building. It is divided into three sections by two clutches. The first, some 5 ft. from the turbine shaft, is a four-jaw mortise clutch, and cuts off the entire plant. The second clutch is of the friction type and controls the third section of shaft, which supplies power to the rubber works. In case of necessity this section can become a source of power, for the rubber factory also has a 200-h.p. Harris-Corliss engine, which is sometimes used in conjunction with the water wheel and sometimes separately. The middle section of the shaft is 6 ins. in diameter, and carries an 8-ft. pulley which drives a line of counter shafting on the floor above. This pulley has an 18-in. face and transmits its power by means of a two-ply 15-in. belt. To the latter counter-shafts the dynamos are belted, for the most part directly. This shaft may be driven by the auxiliary engine already referred to, which is connected thereto by a clutch pulley. This engine, which was made by the Ball Engine Company of Erie, Pa., is of the single-expansion high-speed type. It receives steam at 90 pounds pressure from the rubber factory boilers, and exhausts into the atmosphere. As it is seldom used, the expense of condenser or heater is not justified.

The electrical equipment of the plant consists of two Edison bipolar dynamos, two boosters and 134 cells of storage bat-

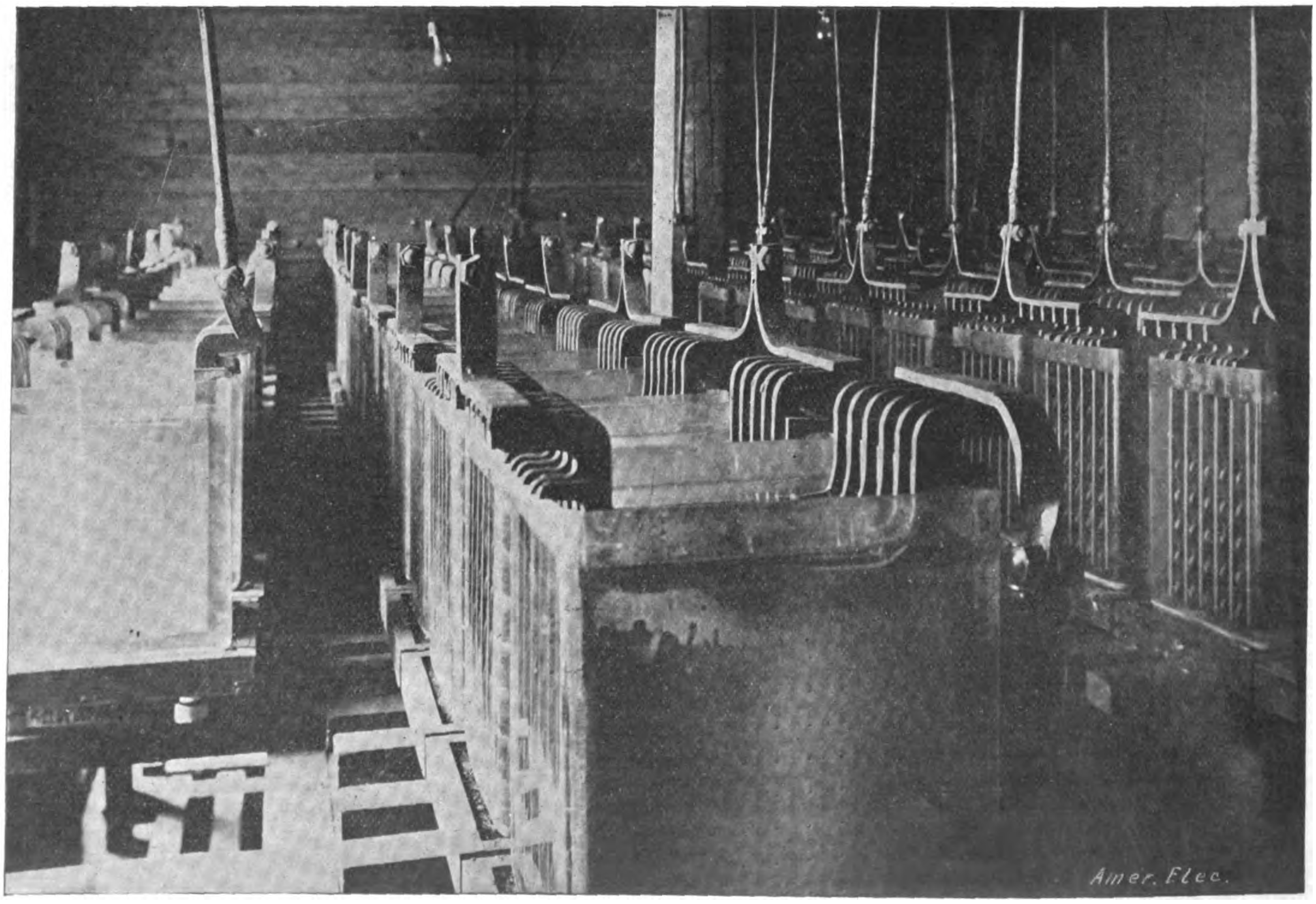

FIG. I.—STORAGE BATTERY ROOM.

tery, all connected on the three-wire system. An arc service is also provided by means of a Thomson-Houston 50-light 2000-c.p. arc dynamo and an appropriate switchboard.

The Edison machines are of the familiar bipolar type, and need no special description. They are of 25 k.w capacity, and adapted to be switched on to either leg of the three-wire system by the customary double throw head board switch. Their foundations are bolted to the floor timbers and, although the latter are not reinforced, the vibration is not noticeable. These machines deliver their output at 125 volts to a main distributing board supplied with Edison fixtures, protected by T. H. lightning arresters.

The boosters are of the Manchester type, and were made by the Electric Storage Battery Company, of Philadelphia, Pa. They are rated at 50 amperes at 70 volts, and operate at 900 r.p.m, being driven from a small counter shaft on the ceiling.

From Fig. 2, a general view of the plant, the arrangement of the machinery will be readily understood. From the main board three feeders run to the storage battery switchboard. A double-throw switch on the latter is provided, by which the batteries can be switched to discharge into the lighting system, or connected to the dynamos in series with the boosters. Fig. 5 will assist in making this arrangement plain.

During the seasons of heavy load the batteries and dynamos are connected directly in multiple, and all contribute to the station output. After the peak of the load has passed, the voltage applied to the batteries is increased by the boosters and the former charge. During the day the batteries carry the entire load. In this way constant service is attained by running the plant about six hours daily.

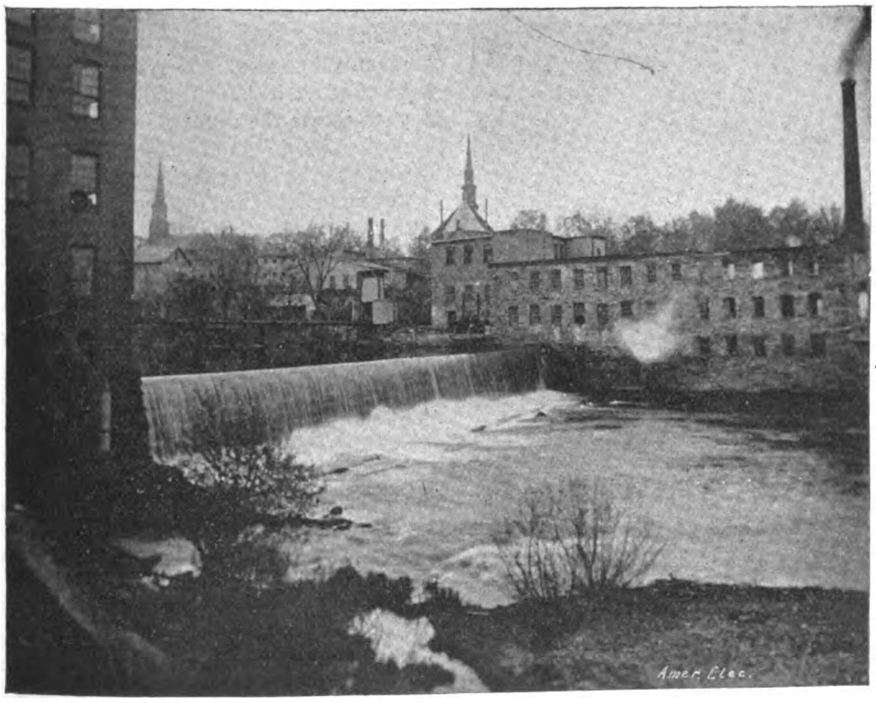

FIG. 2.—VIEW OF DAM.

The battery switchboard, shown in Fig. 4, comprises a differential ammeter and a voltmeter, both of the Weston round type; a ten-point battery switch, a booster rheostat and an underload switch, which breaks current should the batteries tend to motor the dynamos. These instruments are duplicated on each leg of the system. There is, further, a double-pole, double-throw switch already referred to, which cuts out the boosters. Fig. 5, showing the switchboard connections, will render the arrangement readily understood.

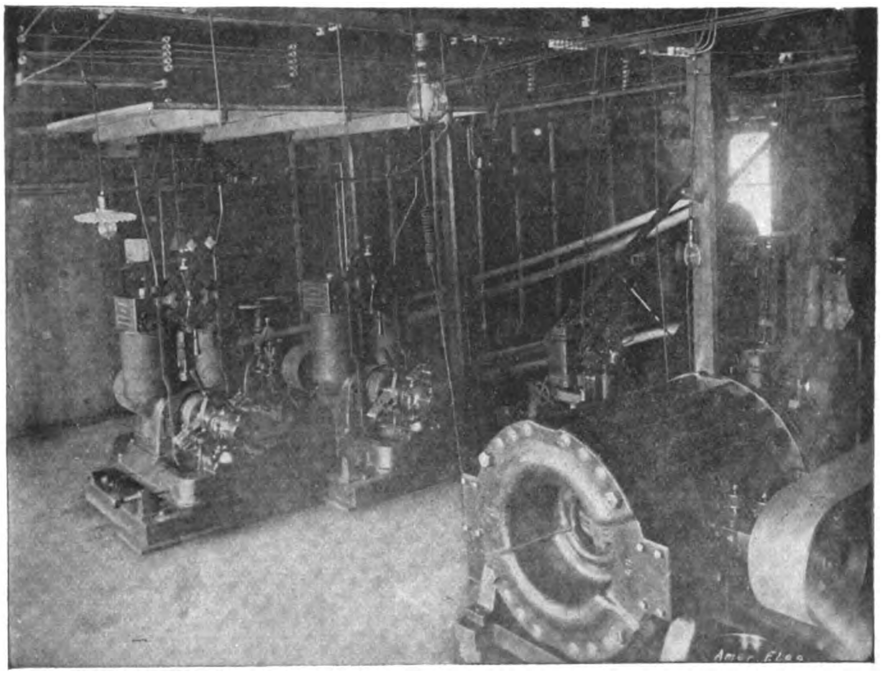

FIG. 3.—DYNAMO ROOM.

The underload switch is worth a few words, as it is quite ingenious. It consists of an iron core pivoted at each end to a horizontal brass support, which is fastened to a vertical piece of slate. At the ends of the core and at right angles thereto are secured heavy iron pole pieces. The supports extend beyond the core and carry an iron armature, which, when the switch is closed, completes the magnetic circuit. Around the core are wound a few turns of heavy wire with the ends bent in such a way that when the switch is closed they dip into mercury cups, completing the circuit from one main through the booster and battery back to the neutral. Should the booster voltage fail from a broken belt or other cause, the voltage of the charging circuit would drop to that of the dynamo, and the consequent reduction in current would allow gravity to act on the heavy pole pieces of the switch, causing the latter to fall and open circuit.

The battery plant was furnished by the Electric Storage Battery Company, which also supplied the switchboard. It consists of one hundred and thirty-four cells, sixty-seven on each leg, and by means of the regulating switch this number can be reduced to fifty-eight on a side. The cells are chloride accumulators, with Manchester positives. They are arranged on racks in three banks, as shown in Fig. 5. Each cell rests in a shallow wooden trough, which is supported upon four grooved glass insulators. The grooves in the insulators surround the supporting part and are flooded with oil. This effectually cuts off creeping currents. In order to absorb acid, the troughs are filled with sawdust. The insulators are so placed on the racks that the wooden troughs are separated by a distance not exceeding one inch. The jars are of glass, 10⅜x12½ in lateral dimensions and 15 ins. high.

Each cell has five positive and six negative plates. These are supported by lugs, which rest on the edge of the jar and are kept apart by hard rubber U-shaped separators. The grids clear the bottom of the jar by ¾ of an inch, which effectually prevents accumulated sediment from short circuiting them. Plates of like polarity are burned on to a massive lead bus-bar, and the unlike poles of the separate cells are connected together by brass bolts. The exposed portions of these bolts are coated with lead, which effectually protects them from fumes, and by this means a readily detachable non-corrosive joint is secured.

The complete cell weighs 250 lbs., and can be seen in detail in Fig. 6. Acid of a specific gravity of 1200 Baume is used, and is kept at that density by a weekly increment of about one pint of water. This constitutes the attention that the cells receive, and though they have been in constant service over two years, it would take a keen eye to detect any deterioration of the plates. They are free from fuzzy deposits, and have the same clean, firm appearance that newly installed plates possess. The cells have been cleaned once a year. The charging rate is 50 amps. and the discharging rate is the same, though at times 100 amps. have been drawn from the cells. The rated capacity of each cell at 50 amps. is 400 amp. hours.

The room is well protected from the action of fumes by thorough ventilation, and as an additional precaution it i lined with tar paper.

The distributing system has its centers in two poles, which are each supplied by a pair of feeders from the lighting station. From these points pressure wires are brought back to the switchboard voltmeters and the pressure is adjusted with reference to indication of these instruments.

The incandescent lamps used are of 16 c.p. The rates are low, being 15 cents per k.w.-hour, and correspondingly reasonable flat rates are made on special contract. The arc system is in two circuits, and 45 lamps are located throughout the town. The rate on the arc lamps is $65 per year.

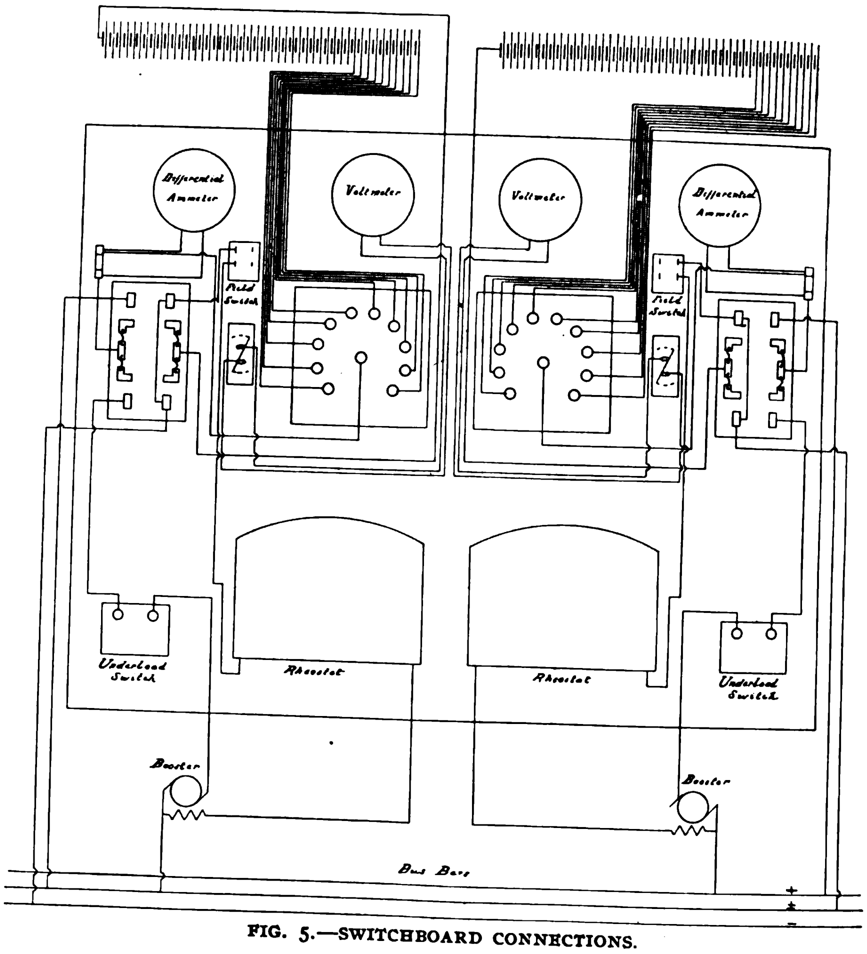

FIG. 5.—SWITCHBOARD CONNECTIONS.

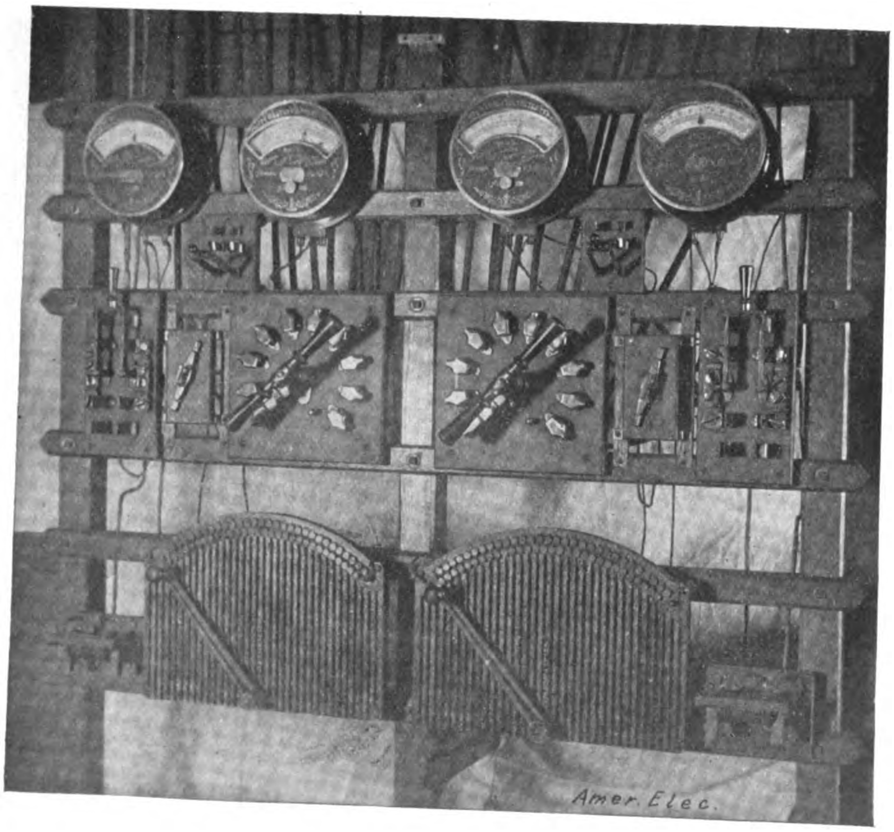

FIG. 4.—SWITCHBOARD.

The water wheel requires exact regulation only when the dynamos are running, for the large Corliss engine keeps the speed steady enough for the stamping machines of the rubber mill. At night the electric plant starts and monopolizes the water power. It is obvious that if the dynamo load is constant the speed will be so also, and so perfectly do the storage batteries accomplish the condition of constant load that the speed is sufficiently constant for incandescent lighting, the requirements for which are most exacting. In fact, a very efficient water wheel regulator has been abandoned and now stands idle in the plant. Of course, this arrangement will not be effective if the hydraulic head varies. In such a case the regulation must be accomplished by the gate, but this variation is so slow that hand regulation is convenient and satisfactory. That the batteries have been the source of considerable money saving is unquestioned, and the following statement given out by the company illustrates how the economy is apparent:

"In the month of January, 1896, before the batteries were installed, it was found necessary to run the auxiliary engine some 180 hours to supplement the water wheel. During January, 1898, after the batteries were installed, the same conditions as regards available water load prevailed. The station load was 33 per cent heavier, and yet it was only necessary to run the auxiliary engine 13 hours during the month. As the company was at the expense of coal, firing and boiler rent, this constitutes a considerable saving, and it is safe to say that the storage batteries have paid for themselves by this time. The service also has much improved, for current in the lines at all times enabled the company to secure more subscribers. This condition can be obtained in no other way excepting at a large expense."

From the foregoing description it will be seen that the plant is the result of a very moderate outlay in inexpensive machinery, but the storage battery has enabled it to supply a service that cannot be improved upon. It is practically impossible for the service to be interrupted. There are three prime movers, namely, the turbine, the auxiliary and the rubber mill engines, and any or all of them could be used. There are also the dynamos and the storage battery, either of which could temporarily handle the load when the batteries were just put in. However, the station load has grown since the instalment of the batteries, and the maximum is now nearly equal to the combined dynamo and the battery capacity of the station.

The entire force employed in this plant consists of a superintendent, a dynamo tender and a lineman, who also does the trimming. Before the battery was installed there was, in addition, a licensed engineer, and at that time the average load was considerably less than at present.

Although this plant contains nothing radically new, either in apparatus or arrangement, it is believed that it is a significant illustration of the value of storage batteries in small electric plants. It produces practically constant and full load on the dynamos during their operating hours. It keeps the speed constant on the one hand and the voltage on the other. In the case of steam plants, full continuous load enables the machiney to always operate at its highest efficiency, and effects a substantial saving at the coal pile. The feature of continuous service, however, has the greatest money value. Continuous service will always result in increased custom, particularly if there is a local gas company and competition is keen. There are thousands of plants in the United States to-day, both central station and isolated, that could materially benefit themselves by securing this most valuable feature and the incidental economy, and there are many that are contemplating increased capacity that can ill afford to overlook this most obvious method of supplying their needs.

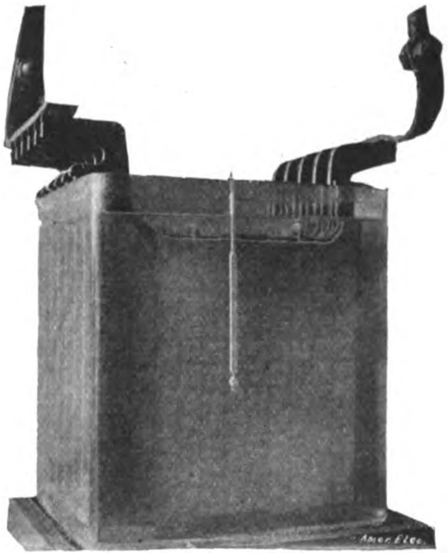

FIG. 6.—ONE OF THE STORAGE CELLS.

The discouraging early history of the storage battery has been largely responsible for the lack of general appreciation of its value in such cases as have just been recited. It has, however, fought its way through the almost insurmountable commercial obstacles that its premature exploitation cast in its way. It may now be confidently stated that the modern storage cell is an assured success for all stationary work, and since engineers have succeeded inventors the doubts that have impeded its progress have been dissipated.

A MODERN ARC LIGHTING PLANT.

A TRANSFORMED ARC LIGHT STATION.

An interesting transformation from a generating station, dependent upon boilers and steam engines for its motive power into one directly driven by high tension three phase current, is now being carried out without interruption to the lighting service by the Edison Electric Illuminating Company of Brooklyn, in what was the central station of the Citizens' Electric Illuminating Company. Last year the Brooklyn Edison Company absorbed the Citizens' Company, which owned an important and necessary overhead franchise, and up to a recent date continued the operation of its high tension series arc system from the existing steam station. As soon, however, as the great Union station at Bay Ridge was in condition to furnish current in sufficient quantities plans were perfected for the conversion of the central station into one of the substations of the great Brooklyn system, dispensing entirely with the steam plant.

The station is situated at the lower corner of Navy Street and De Kalb Avenue, and consists of two separate buildings, a two-story structure, in which the original Thomson-Houston generators were located, and a newer three-story building, formerly occupied by the Brush arc light machines. A part of the newer building only will be occupied by the remodelled plant.

The equipment of the old steam plant consisted of three 400 h.p. Wright-Corliss engines, two 400 h.p. vertical triple expansion McIntosh and Seymour engines, and one 1200 h.p. Hamilton-Corliss twin compound engine. These drove through counter-shafting twenty 120-light 1200-c.p. Brush generators, which replaced the smaller capacity T-H machines. In addition, two 150-h.p. Edison bipolar motors,

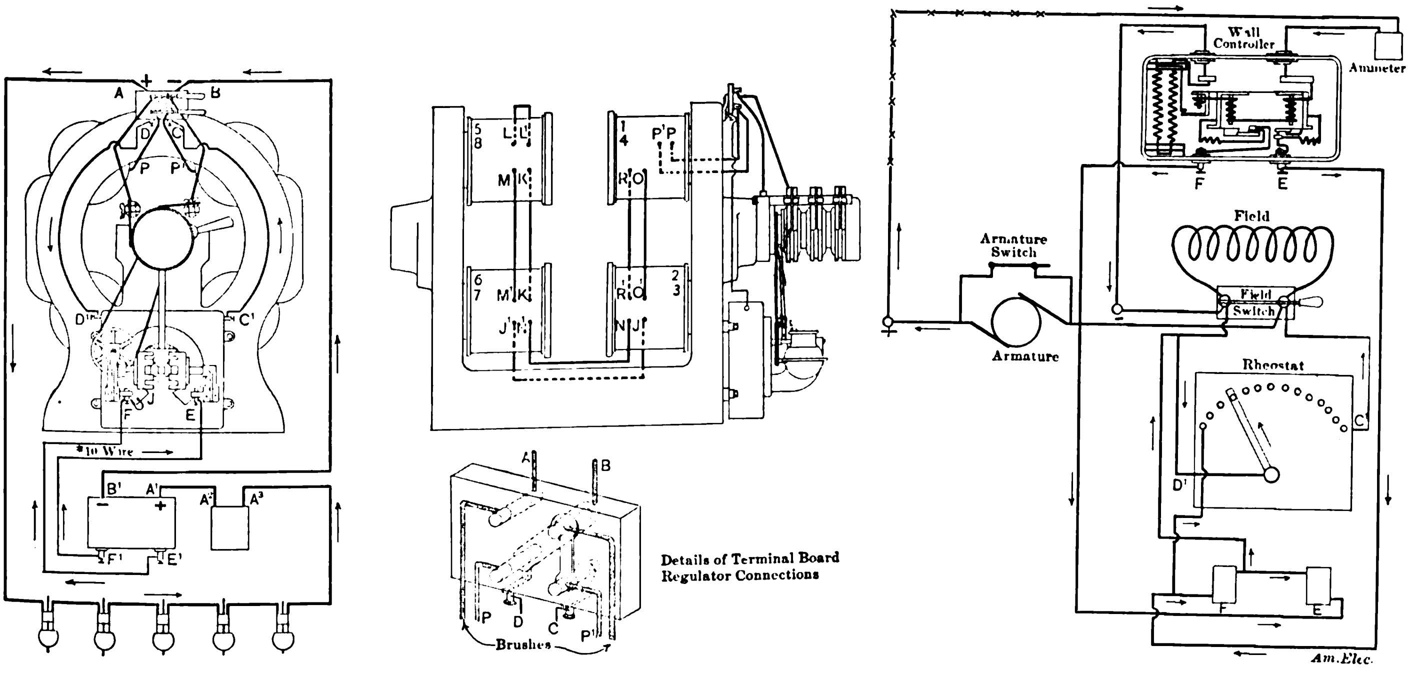

FIG. 1.—ARC MACHINE CONNECTIONS AND ELECTRICAL CIRCUIT.

operated by current from the low tension mains, furnished additional power after 7 at night, when the high tension arc load was thrown on. During the day the motors were driven as generators by the engines feeding low tension current into the Edison network. All the engines have been removed but the three first named, and these are only retained to drive the machines not yet moved.

The new fireproof building occupied by the substation apparatus has a frontage of 75 ft. on Navy Street and a depth of 100 ft. The lower floor, formerly occupied by the vertical and Hamilton engines and boilers, is below the street level, and is divided into two rooms, the larger 45 ft. by 90 ft., occupie by the synchronous motors, arc machines, booster and switchboards; the smaller, 24 ft. by 90 ft., containing an extensive storage battery plant. The upper floors will be occupied as storerooms, repair shops and the inspection department. Fig. 2 shows the lay-out of the second floor of the new building when the Brush machines were driven through counter shafting from the engines on the first floor. Fig. 3 shows the lay-out of the first floor. The comparison is most striking. The entire new plant occupies only the space formerly occupied by the steam portion alone of the old arc-lighting plant.

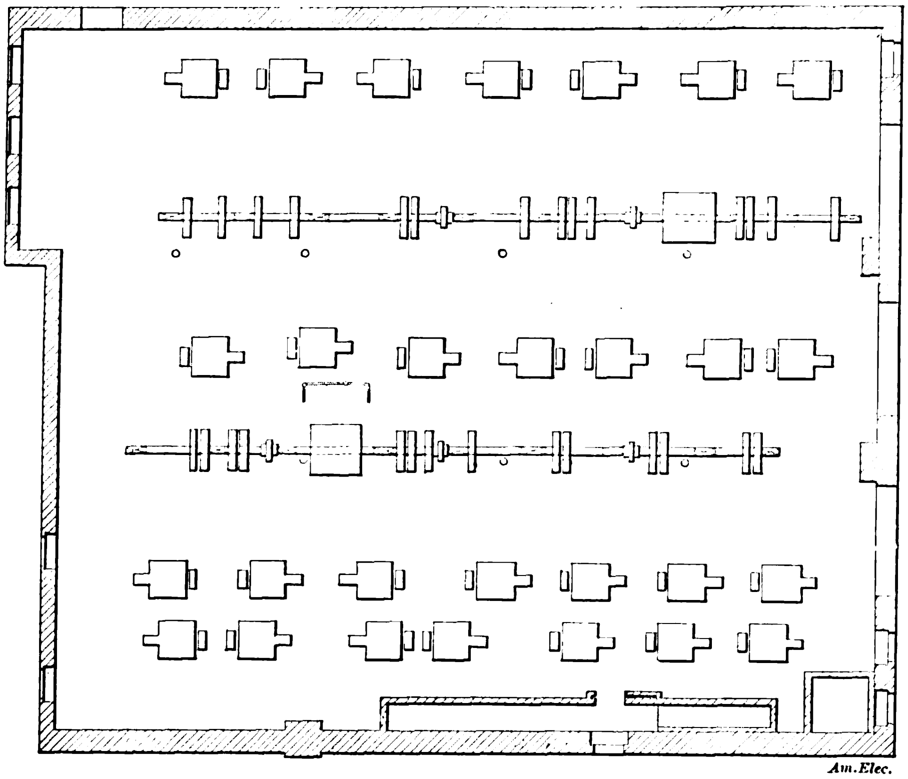

FIG. 2.—PLAN OF ABANDONED SECOND FLOOR WITH MACHINES BELT DRIVEN FROM COUNTERSHAFTING.

The method of driving the arc generators is similar to that to be followed at Buffalo and at Boston. Each unit consists of one General Electric 100-k.w. synchronous motor, directly connected to two 120-light Brush arc machines—one at each end of the shaft—the three machines being set on a heavy pine timber sub-base. The shaft of the motor is extended at each end, and is coupled to the shafts of the two arc generators by flexible couplings, consisting of two four-armed stars interlocking over rubber cushions. The commutators of the Brush generators are at either end of the set, facilitating inspection and attention.

The motors are classed as four-pole 100-k.w. revolving field machines, running at 750 revolutions. The stationary armature is similar in construction to that of the standard General Electric revolving field generators or to the field of an induction motor. Each pole has, wound close to the iron, a heavy copper strip short-circuited upon itself, the ordinary field winding being outside of this copper strip or shield. The ends of the ordinary winding are carried to two collector rings, furnished with carbon brushes. These motors are designed for a field excitation of 125 volts. The stationary armature is provided with a substantial connection board placed at one side near the base, and the leads brought out from this are furnished with couplings completely encased in hard rubber.

Each motor has a three-phase reactance coil, placed in circuit with the armature when starting and cut out by a switch when the machine has reached synchronism. By means of this reactance a limit is set to the current taken from the line when starting, and the potential of the transmission lines thus remains unaffected. A field rheostat is also provided with each motor to allow of the adjustment of the field excitation, so that the minimum current input will be taken for any given load. These motors take the full voltage current from the transmission lines from the Union station—6000 volts—without the intermediary of reducing transformers.

The dimensions of the motors are: From bottom of iron base to top of armature frame, 52½ ins.; length over ends of shaft, 86 ins.; width over base, 57½ ins.; approximate weight, 11,000 lbs.

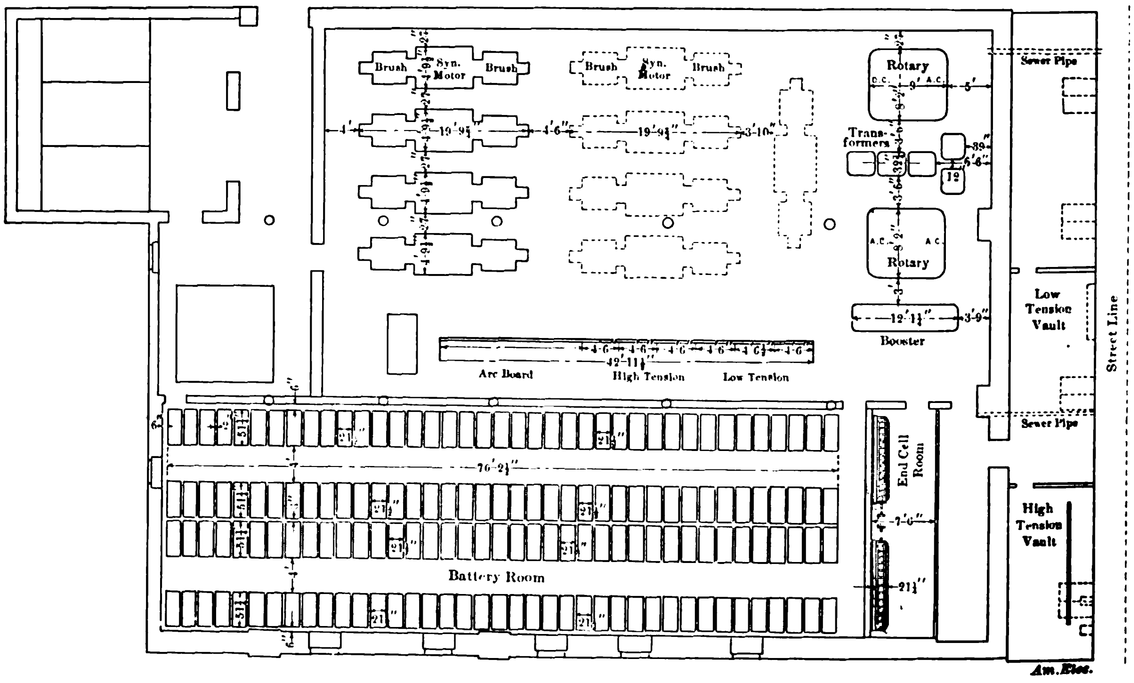

FIG. 3.—PLAN OF NEW STATION.

The arc light generators are four pole open coil Brush machines, with the rating of 6,000 volts and 6.6 amps., at a speed of

700 r.p.m. The design and construction have been carried out on very liberal lines, with ample strength of cast iron in both frame and bed plate. The ball bearings are self-aligning and self-oiling, are of ample size and run very cool—about 20°F. above the surrounding air after 10 hours' run. The pulley bearing is a plain straight bearing, while the commutator bearing has six thrust collars to provide for the magnetic pull in this type of machine.

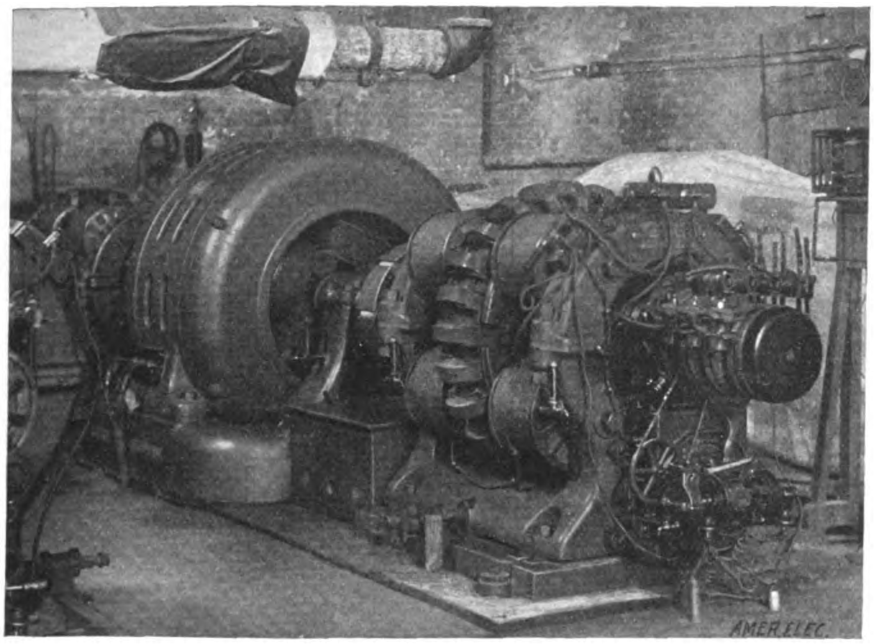

FIG. 4.—A 240-LIGHT UNIT.

The armature is built up on a gun metal spider clamped in a winding form. The end of a thin steel ribbon is screwed to it, and the ribbon is wound upon it, paper insulation being placed between each layer. Cross pieces are placed between the ribbon to form teeth to wind the bobbins between, and filling-in pieces are placed between the different armature teeth. The band is wound under heavy tension, and clamps are placed upon the spider over the iron, clamping it down and making the whole a solid mass. The core is attached to the spider by rivets, insulated from the core and riveted to the spider.

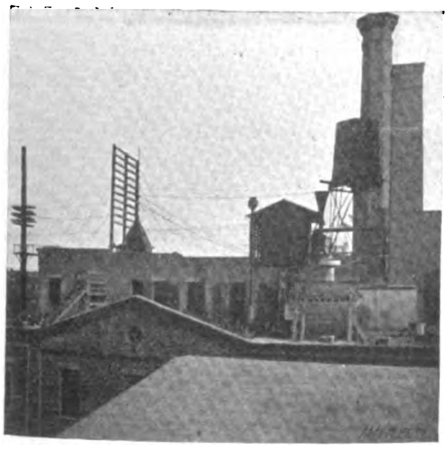

FIG. 5.—ROOF, SHOWING OLD LINES

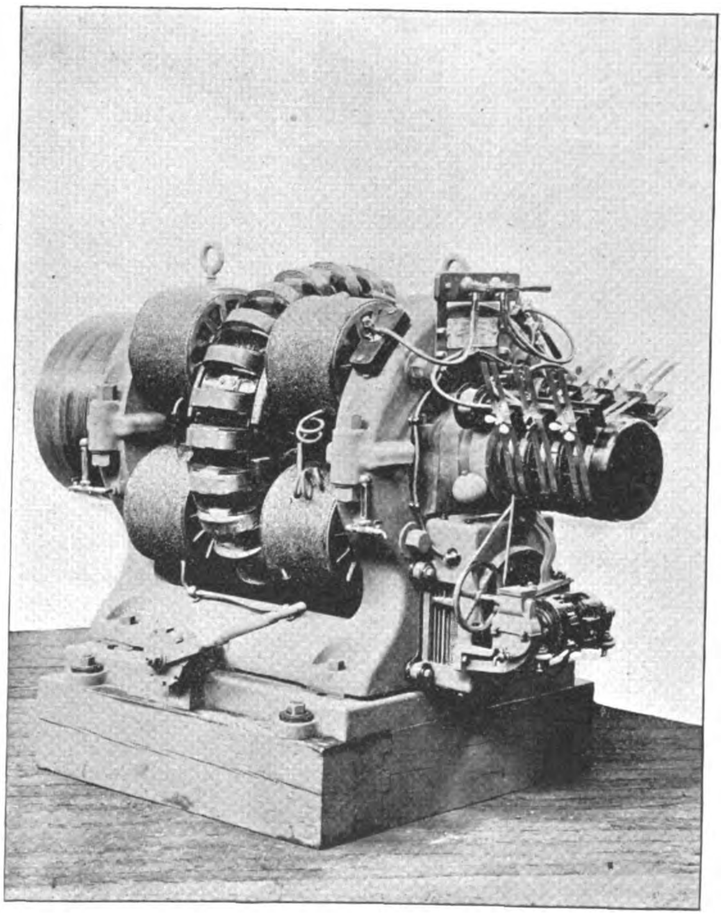

FIG. 6.—125-LIGHT ARC MACHINE.

The boxes in which the armature bobbins are wound are made of red rope paper, mica and shellac, built up on forms in two halves, with dove-tailed joints. The box is driven tightly on the armature core and the winding applied, interposing a layer of muslin between each layer of wire. The bobbin is constructed of rectangular cross sections to avoid crossing wires at sharp angles and lessening their life. The core is balanced, and the completed armature again balanced after winding. This is, however, not of frequent necessity, the armature usually being in perfect balance when it leaves the winder's hands. The wires connecting the armature bobbins to the commutator are of flexible rubber-covered cable run through a mica tube in the shaft.

The construction of the commutator has been the object of the greatest care. It is built upon an iron shell fitted upon the shaft. The commutator rings are built up of wood in small pieces glued together and fastened with screw dowels, then thoroughly dried and afterward soaked in oil. The rings are then turned to fit upon the iron shell, and the outside periphery turned to allow mica rings to be fitted upon and cover it. The ends are then turned off securely and fitted with mica end plates. The brass segments which hold the copper segments are then secured down upon the mica covered wooden rings. The cross connecting wires are put in grooves, covered with burned shellac and protected by mica end plates. The copper segments are then mounted upon the brass segments, the wooden blocks are fitted into their places and the whole is turned off.

The field magnet spools are wound upon brass shells, the insulation used being red rope paper, mica, rubber cloth and shellac. The winding is protected by a rope cover. There is ample insulation at all points, and especially long surface insulation.

The regulation is secured by automatic shifting of brushes and variation of current in the fields by means of a rheostat attached to the machine beneath the commutator. The diagrams show the connections of the machine with wall controller, regulator, etc.

The total floor space taken up by one set of two arc machines and one synchronous motor is, length over commutators, 19 ft. 9¾ ins.; width, 57½ ins.

Four 240 light units are now installed and the remainder are fast being placed in position. The ultimate capacity of the station as at present laid out will be eighteen 120-light arc machines and nine synchronous motors.

At the east side of the room will be set up two General Electric rotary converters, three static transformers cooled by air blast, and two induction regulators; current at 6000 volts and 25 cycles will be fed from the transmission lines into the static transformers, in which the pressure will be reduced to 83 volts. At this pressure it will pass to the rotary converters and will be delivered as 125-volt current to the storage battery, and the low-tension Edison network. Each rotary is of 200 k.w. capacity, and runs at 375 revolutions per minute; each static transformer is of 150 k.w. capacity. The air for cooling purposes will be furnished by a 1 h.p. bipolar ironclad motor. By means of the induction regulators the voltage of the direct current from the rotary converter is regulated by variation in the 83-volt secondary from the static transformers.

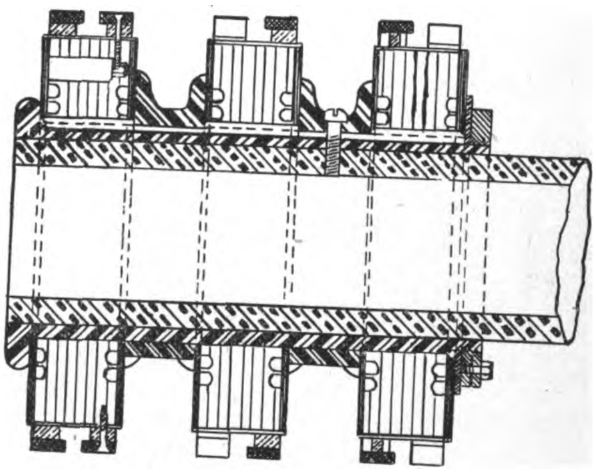

FIG. 7.—SECTIONAL VIEW OF COMMUTATOR.

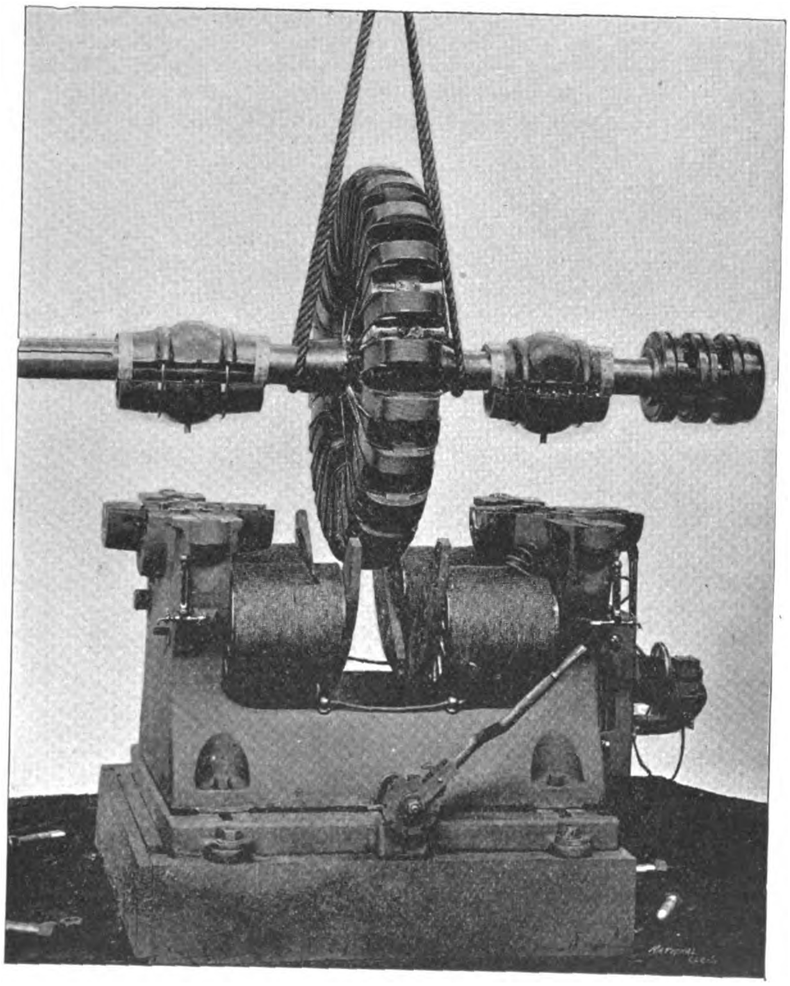

FIG. 8.—120-LIGHT ARC MACHINE, SHOWING ARMATURE.

The storage battery occupies a spacious room, formerly occupied by the boilers, to the south of the main dynamo room, and the cell regulating switches a small room on the Navy Street side, in as close proximity as possible to the end cells of the battery. The cells number 156 and have a total capacity of 1200 amps. for ten hours, 3000 amps. for three hours and 6000 amps. for one hour. The positive half of the battery is on the right side of the room, the negative on the left of the room. This battery was installed by the Electric Storage Battery Company, and acts as a reserve in the event of accident to the main station. It is designed to cope in case of accident with the entire demand of the district, including the high-tension series system, for a period of two hours, in which time the reserve stations may be started and thrown on. The battery is charged from the Pearl Street station through a Churchward booster. It discharges simultaneously and is connected at all hours to the low-tension mains for purposes of regulation.

The method of operation of the high-tension arc plant in case of break-down to the 6000-volt transmission lines is simple. It consists merely in reversing the normal operation of the battery, rotaries and transformers—the battery discharging to the rotaries, which deliver low-tension, three-phase current to the transformers, which, in turn, deliver to the synchronous motors the 6000-volt current necessary to their operation. That this may be readily and successfully effected is proved by the fact that when the Union Station is under heavy overload it is helped out by driving the synchronous motors from the battery in the manner stated.

The cell-regulating switches are now operated by hand wheels, but ½-h p. Lundell motors will shortly be installed to drive the worm gearing connected to the screws on which the contact brushes travel. The motors will be controlled from the main switchboard and may be run in either direction, throwing in or cutting out cells as the conditions require. By a novel arrangement the switchboard operator will be able to see when the travelling contact brushes are in normal position on the contacts. This will consist of two 16-c.p. incandescent lamps placed over each of the motor-control switches, and so connected that while the brush travels from one contact to another they will be in series across the 110-volt circuit, and will, therefore, burn dimly. When the brush is exactly over a contact one lamp is extinguished, the other burning to full candle-power. The operator is thus made aware that the motor must be stopped. An indicator, with scale and needle, shows the number of cells in circuit. This is operated on the same principle as a Wheatstone bridge. A resistance wire, stretching the full length of the cell-regulating switch, is in constant

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contact with the travelling brush. The position of the latter is shown on the indicator according to the relative proportion of the resistance wire on each side of the brush, the scale being calculated in divisions corresponding to the contacts on the switch.

The booster, which occupies a space on the south side of the room, is of the Churchward multipolar three-machine type, built by the Excelsior Company. The two end machines are dynamos, each of 1000 amps. and 50 volts capacity, while the center machine is a motor connected to run either on 125 or 240 volts, the former when the dynamos give their current output at a low e.m.f., the latter when they are required to give their current output at a high pressure; thus the dynamos always have a comparatively strong field.

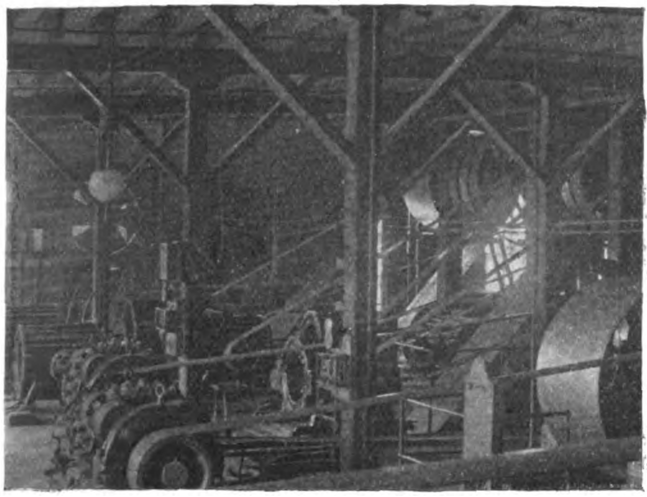


FIG. 8.—PART OF OLD STATION, SHOWING MACHINES BELT DRIVEN.

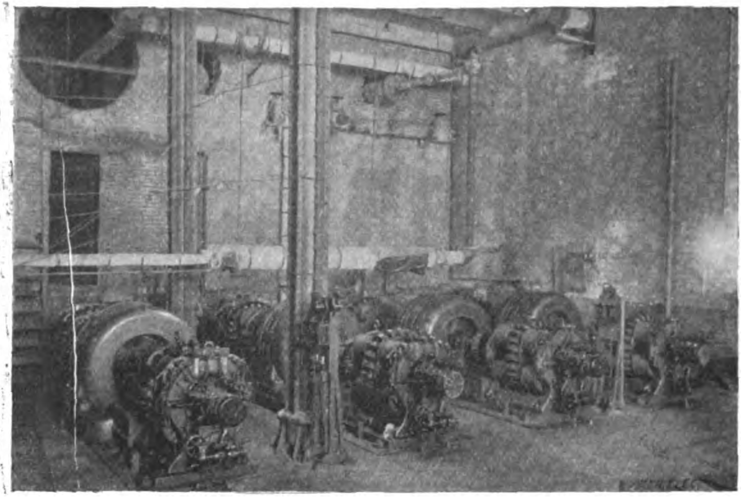


FIG. 9.—FOUR MOTOR AND ARC UNITS, SHOWING SIMPLICITY OF DRIVE.

The brushes are of carbon, and the drop forged commutation bars have sufficient surface to give the brushes bearing enough to carry the current at the low density of 20 amps. per square inch. The fields are separately excited from the station busbars, and the rheostats used have a large number of contact points, permitting of a variation in voltage from 1 volt on open circuit up to 50 volts and 1000 amps. The floor space occuped is 12 ft. 2 ins. by 34 ins. wide and 37½ ins. high.

The switchboard will be over 45 ft. long, and with the exception of the high-tension arc circuit board will be made up of panels of blue Vermont marble. The arc-circuit board will be placed at the end near the west wall of the room. Next to this will be placed the panels, through which the three-phase 6000 current will be supplied to the synchronous motors. Then will come the high-tension board, taking from the distribution switchboard in the vault 6,000-volt three-phase current, and distributing it to the synchronous motor board just mentioned and the next board, upon which are mounted the instruments necessary to the control and regulation of the transformers and converters. The fifth and last board near the east wall is the storage battery switchboard. All the high-tension switches are mounted on corrugated rubber stands and are separated by heavy wooden barriers.

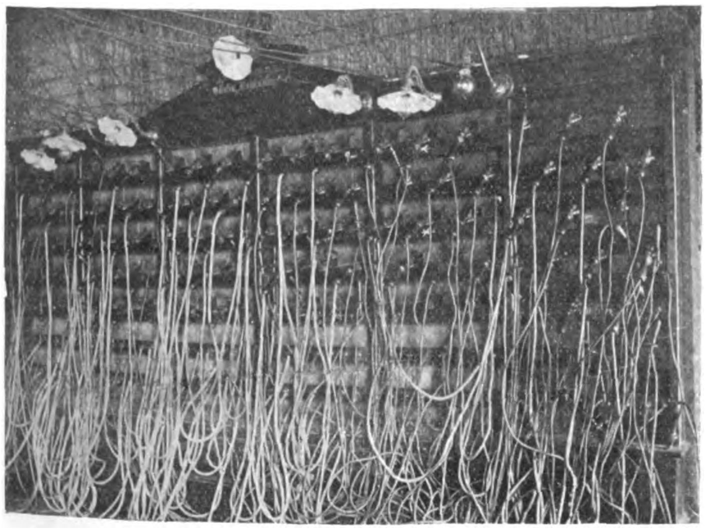


FIG. 10.—OLD ARC SWITCHBOARD ON A BUSY NIGHT.

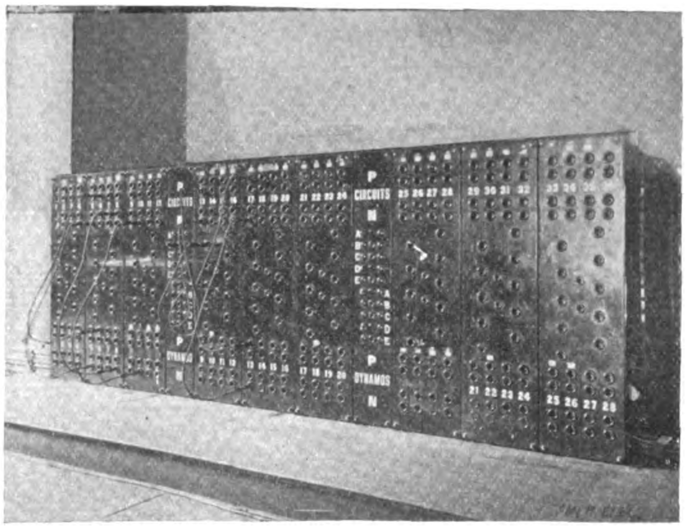


FIG. 11.—NEW ARC SWITCHBOARD, WITH FOUR PANELS CONNECTED.

This station is also the main center of distribution for the 6000-volt current from the Union station, not only to itself, but also to the Williamsburg and Pearl Street substations. The distribution board is erected in a fireproof vault, and consists of four panels of blue Vermont marble, carrying General Electric high-tension, quick-break switches, set on corrugated cones of hard rubber and separated from each other by high barriers of japanned maple in a manner similar to those on the main board. They are pulled open by a hooked stick. This vault is shut off from the room by an iron-barred gate.

The transformation in the interior will extend also to the exterior, and with the steam plant will also disappear the tangle of wires shown in Fig. 5. All incoming current from the Union station is transmitted through duplicate three-wire, lead-covered cables, drawn through earthenware ducts. These cables are paper and compound insulated, and were furnished by the Standard Underground Cable Company after test at from 12,000 to 15,000 volts. All the outgoing mains are also carried underground, the high voltage and low-tension Edison wires in their several conduits. The high-tension series arc wires run underground for a distance of three-quarters of a mile, when they rise, and are carried on poles to the arc lights.

In this remodelled station almost all the benefits conferred on the electrical lighting industry by the introduction of modern methods may be seen and appreciated.

Reference to Figs. 2 and 3 shows clearly the great economy effected in the floor space occupied, while Fig. 10 shows the mass of belting from engine to countershafting and from countershafting to generator formerly necessary, eliminated by the adoption of methods dictated by long experience in the art.

In hardly any other case are the compactness of the devices and subsequent restriction of floor space occupied, simplification of the apparatus and the added flexibility to the general system more strikingly apparent than in this. And when we reflect that this change is being effected without the loss of light from one lamp for a single night the task accomplished reflects high credit on the engineers and electricians who planned and are carrying it out.

MECHANICAL DRAFT..

THE ADVANTAGES OF MECHANICAL DRAFT.

BY WALTER B. SNOW.

The economic progress in steam engineering which has marked the past quarter century has been largely the result of greater refinement in the design and construction of the engine in which the steam is utilized. Future improvement along this line is to be sought principally in the increase of the steam pressure and the expansion ratio. But experimental results which, with a quadruple expansion engine and steam of 500 lbs. pressure, have already shown a steam consumption of less than 10 lbs. per hour per indicated horse power, are indicative of the fact that we are closely approaching the maximum practical efficiency.

Until the recent past, however, the steam generator or boiler and the manner of its operation have received far less attention than they deserve. Although, under the best conditions, over 80 per cent of the full calorific value of the fuel may be utilized in the production of steam, yet it is true that this high standard is seldom reached in ordinary practice. Hoadley showed an efficiency of nearly 88 per cent in his tests of a warm-blast steam boiler furnace equipped with air heaters and mechanical draft. Bryan has reported eighty-six tests conducted under common conditions with ordinary fuel, upon boilers of various types, which indicate an average efficiency of only 58 per cent, and have a range between a minimum of 34.6 per cent obtained with a small vertical boiler, and a maximum of 81.32 per cent resulting from the test of a water tube boiler with improved setting. The possibliities of increased economy in ordinary boiler practice are thus rendered clearly evident.

Of the losses in the efficiency of the fuel used in connection with a steam boiler some are inevitable, while others are to a greater or less degree avoidable. It is with these latter that we have to deal, and it is interesting to note to what an extent the application of mechanical draft is of assistance in their reduction.

The loss resulting from the escape of unconsumed carbon in the form of smoke is probably one of the most noticeable losses, although seldom exceeding 1 per cent in good practice. Even this loss may, however, be almost entirely eliminated and the smoke nuisance may in most cases be practically avoided by such regulation of the air supply and the intensity of the draft as is possible under the conditions of mechanical draft.

In a similar manner, the loss by carbonic oxide—the result of imperfect combustion—may be reduced to an almost infinitesimal amount under proper draft conditions.

The direct loss which ensues from the dropping of small pieces of coal through the grate, and from the presence of incompletely burned coal in the ash, may be greatly reduced by proper grates, having small air spaces, and by the application of mechanical means to produce the draft, which is absolutely required where small-sized coal is employed.

Although, in theory, the amount of air required for the combustion of one pound of coal is about 12 pounds, in actual practice with chimney draft the amount supplied is usually greatly in excess. In the case of sixteen different plants tested by Donkin and Kennedy it was shown by gas analysis that the air supply ranged from 56 to 328 per cent in excess of the chemical requirements. Such an excess brings

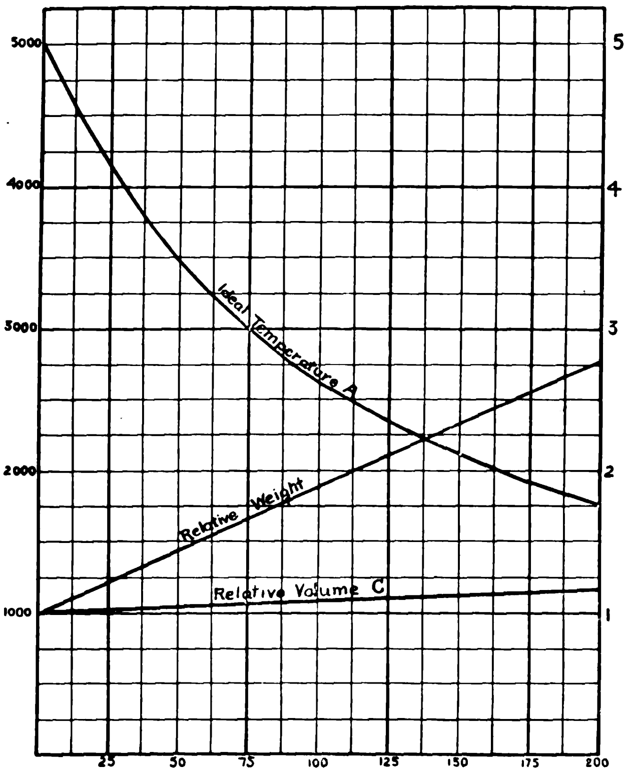


FIG. 1.—CURVES OF TEMPERATURE, WEIGHT AND VOLUME.

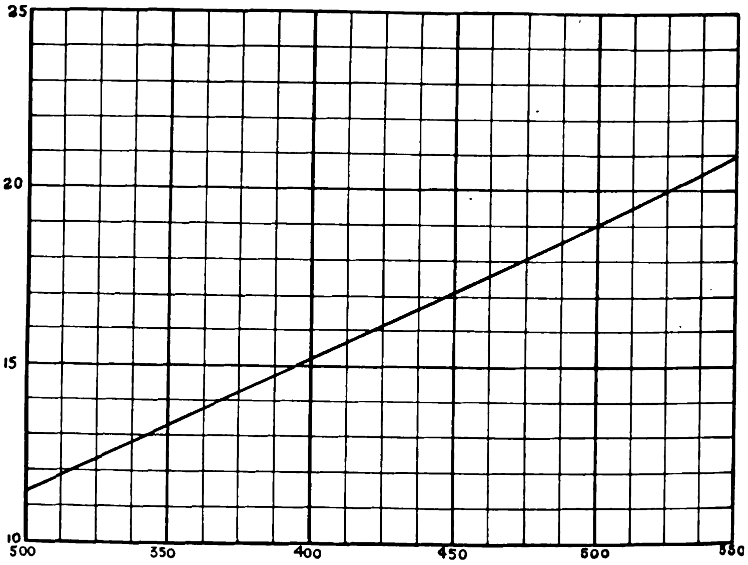


FIG. 2.—CURVE OF LOSS DUE TO HIGH TEMPERATURE

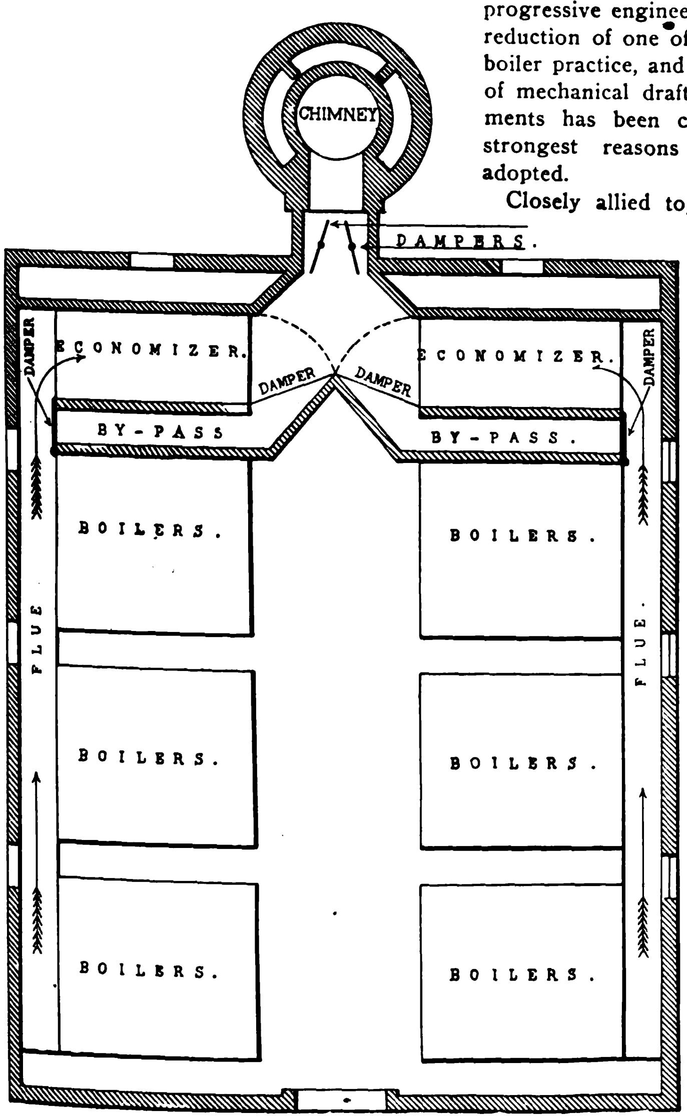
about a two-fold loss: First, the temperature of the furnace is lower; second, paradoxical as it may seem, the gases, because of the lower furnace temperature, their larger volume and higher velocity, actually leave the boiler at higher temperature than with a less excess of air.

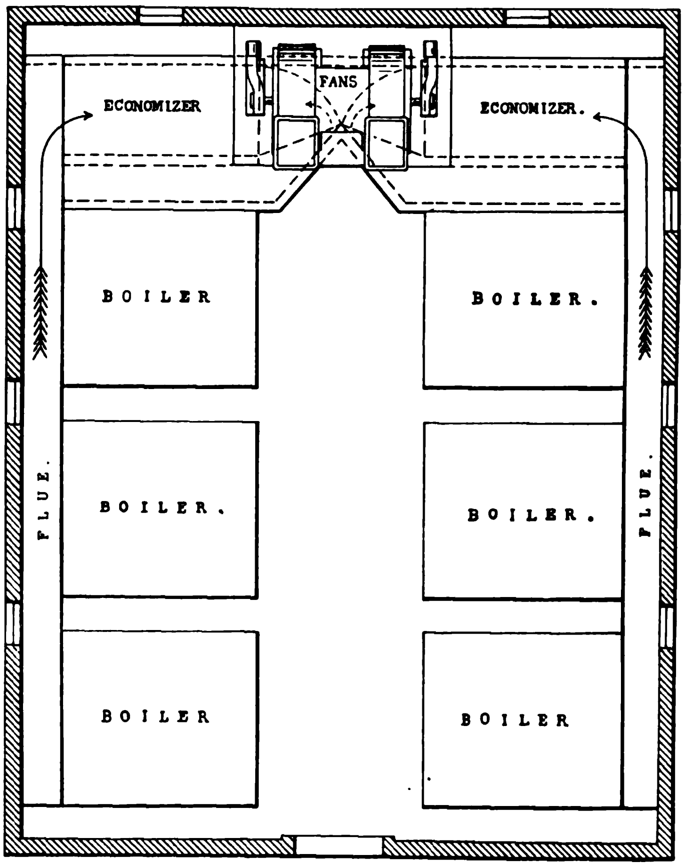
The conditions in the furnace chamber are shown by the accompanying curves, Fig. 1, of which A indicates the ideal temperature for an ordinary anthracite coal; B the relative weight of the products of combustion, and C their relative volume at the ideal temperature.

TABLE I.

EFFECT OF DECREASED AIR SUPPLY ON TEMPERATURE OF ESCAPING GASES.

Day.	Cubic Feet of Air at 62 degrees per pound of Coal	Average Temperature of the Gases Leaving the Boiler.
First	272	624°
Second	198	601
Third	163	550
Fourth	124	497





FIGS. 3 AND 4.—TYPICAL BOILER PLANT, NATURAL AND FORCED DRAFT.

The actual results obtained by M. Burnat, in the case of a boiler provided with special heaters, are shown in Table I..

A high furnace temperature and low stack temperature, other things equal, are evidently conducive to greater efficiency, and the preceding results serve to show that such conditions are incident to a reduction in the excess of air supplied. But perfect combustion with small air supply will only result when it is intimately distributed throughout the fuel. For such intimacy of contact, intense draft and a clean and reasonably thick fire are necessary—conditions which may be most readily maintained by means of mechanical draft.

It appears that if, with a given boiler, the grate area be reduced and the rate of combustion thereon be increased so as to maintain a constant consumption of coal, the air actually required to be furnished per pound of coal will be reduced. Years ago D. K. Clark stated that "the proportion of surplus air required appears to diminish as the rate of combustion and the general temperature in the furnace are increased," and that "the system of forced draft opens the way for increase of efficiency in facilitating the adoption of grates of diminished area in combination with acceleration of combustion." It is along this line that all progressive engineers have sought for the reduction of one of the greatest losses in boiler practice, and the ready adjustability of mechanical draft to the exact requirements has been considered one of the strongest reasons why it should be adopted.

Closely allied to, and, in fact, largely dependent upon the loss due to excess of air, is that resulting from too high a temperature of the flue gases. In the case of the chimney, a certain temperature is absolutely necessary to produce the requisite draft. If economizers or other devices for extracting heat from the gases are introduced, the chimney has to be just so much higher to produce the necessary draft to overcome their resistances. With mechanical draft, on the other hand, the intensity of the draft produced is independent of the temperature of the gases; and in the case of induced draft the lower that temperature the smaller the fan required, the slower the speed and the less the power expended.

The loss due to high temperature of the gases ranges from 10 per cent in the best practice to 30 per cent and upwards in common and poor practice. The theoretical losses with 100 per cent excess of air and different temperatures of the escaping gases above the atmosphere are clearly presented in the curve, Fig. 2, for an ordinary coal having a calorific value of 11,720 B. T. U. This heat may in most cases be abstracted by proper forms of air or water heaters, retarders, ribbed tubes or the like. By means of feed-water economizers Roney reported an average saving of 14 per cent in the case of nine plants equipped therewith and with mechanical draft. Hoadley succeeded in reducing the total waste in the flue gases to 5 per cent of the calorific value of the fuel, only 1 per cent of the total steam generated being required to operate the blower employed to produce the necessary draft.

The methods of application of mechanical draft, by means of fan blowers, may be broadly classified under two heads—the plenum and the vacuum methods. Except upon shipboard, the plenum method is employed only under the conditions of a closed ashpit into which the air under pressure is forced. Various methods are adopted for the admission and regulation of this air. A special form of damper placed in the bottom of the ashpit or in the face of the bridge wall generally serves the purpose. It must, however, be so located as to prevent direct impingement of the air currents upon the grates and fuel.

Under the vacuum method there is practically only one means of application—that by the introduction of an exhausting fan in the place of the chimney. This is commonly known as the "suction" or "induced" method. The fan serves to maintain the vacuum which would exist if a chimney were employed, and its capacity can be made such as to handle the gases which result from the process of combustion. A short and comparatively light stack usually serves to carry these gases sufficiently high to permit of their harmless escape to the atmosphere.

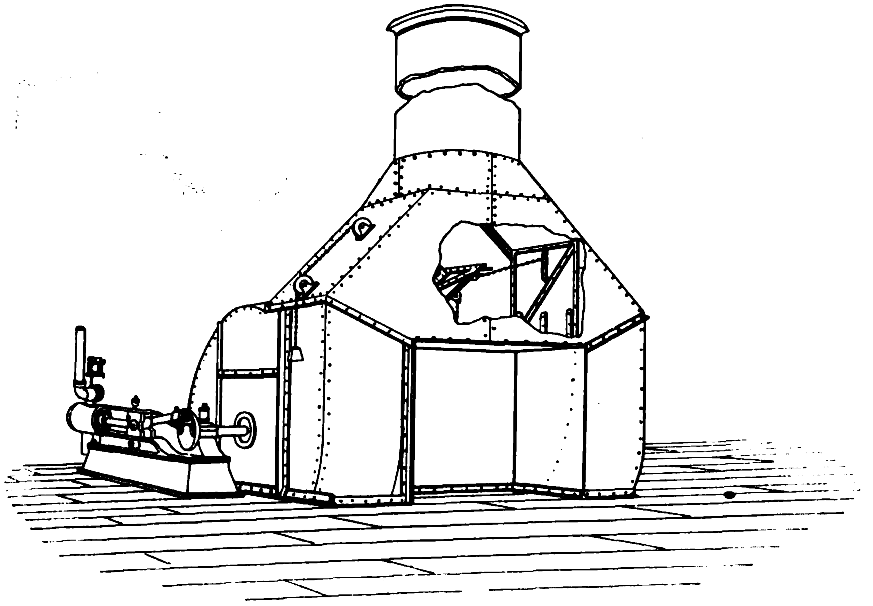


FIG. 4.—APPARATUS FOR FORCED DRAFT.

The method of application which is most suitable must depend upon the circumstances. In fact, it cannot be said that either of these two principal methods is the better. Each has its peculiar advantages.

The efficiency of mechanical draft must, of necessity, be judged from a commercial standpoint. The two principal factors in commercial efficiency are the first cost and the operating expense. The relative cost of a chimney and a mechanical draft apparatus for producing the same results can best be shown by the consideration of a typical boiler plant. Such is shown in the accompanying Fig. 3.

The plant consists of twelve modern water-tube boilers set in pairs upon either side of a substantial boiler house. Each boiler is of 200 rated h.p., making the total 2400 h.p. An economizer of suitable size is provided for each battery of six boilers and the gases pass either through these economizers or by-pass around them to a chimney 9 ft. in internal diameter by 180 ft. high.

In round numbers, the cost of the plant is, in detail, as follows:

12 boilers	$37,000
2 economizers	10,500
Boiler and economizer settings and by-passes	9,000
Automatic damper, regulators, and dampers	400
Chimney, including foundations	10,200
Boiler house	11,500
	$78,600

Of course these figures would vary somewhat with the locality and conditions, and the chimney cost might be vastly increased if built upon unstable ground.

Fig. 4 serves to show the method of application to the same plant of an induced mechanical draft apparatus. The chimney, of course, is omitted, and the duplex fan—representing a most complete equipment—is placed overhead between the economizer ends and entirely within the boiler house.

The general form of such an apparatus is as indicated in Fig. 5. Two steel plate fans are supported side by side upon a steel beam framework carried by the boiler and economizer settings and the end wall of the building. Each fan is driven by an independent horizontal engine, automatically regulated by a special device so that the fan speed increases as the steam pressure falls. Between the fans is an enclosed space to which the gases pass. By means of a swinging damper these gases may be caused to pass to either fan, and by a similar damper in the breeching above the fan outlets, either fan may be entirely shut off. As each fan is of sufficient capacity to operate the entire plant, the other may serve as a relay. All necessity for stoppage due to accident is thus avoided and access to the disabled fan is made simple and comfortable.

An apparatus such as is here represented could be installed complete with supporting framework, inlet and outlet connections and short stack, for about $4700. Evidently this cost would be far less if only a single fan were employed. As it is, the damper regulator and flue dampers are omitted and the actual cost of the draft producing apparatus is as follows:

Chimney Draft.		Mechanical Draft.	
Cost of chimney	$10,200	Cost of mechanical draft plant complete	$4,700
Cost of damper regulator and dampers	400	Saving by using mechanical draft	5,900
	$10,600		$10,600

There would be a further saving in first cost due to decreased space occupied, which in the case of valuable land in a city would be an appreciable item. This factor is also of account when a larger output is obtained from a given plant by means of mechanical draft instead of chimney draft. For this amounts to a smaller plant and less space occupied for the same output when mechanical draft is used.

Fig. 6 represents another example of the application of induced draft.

A problem that has to be faced sooner or later in most boiler plants is that of increased capacity. This may be secured in two ways, either by increasing the output of the existing plant or by adding additional boilers. Suppose, for instance, it is desired to increase by 16 2-3 per cent. the capacity of the plant shown in Fig. 3. With chimney draft, supposing the chimney capacity to be sufficient, it would be necessary to install more boilers, in this case, two, which would in turn require the enlargement of the boiler house. On the other hand, at the sacrifice of a slight percentage of efficiency (which might be more than offset by the ability to burn cheaper fuel) the original plant of twelve boilers might be made to do the increased work by the aid of a fan applied for forcing the draft on the closed ashpit system. Such a fan, with engine, ducts and dampers, could probably be installed for about $1200. Taking the figures first given the relative costs of the two plants would be about as follows:

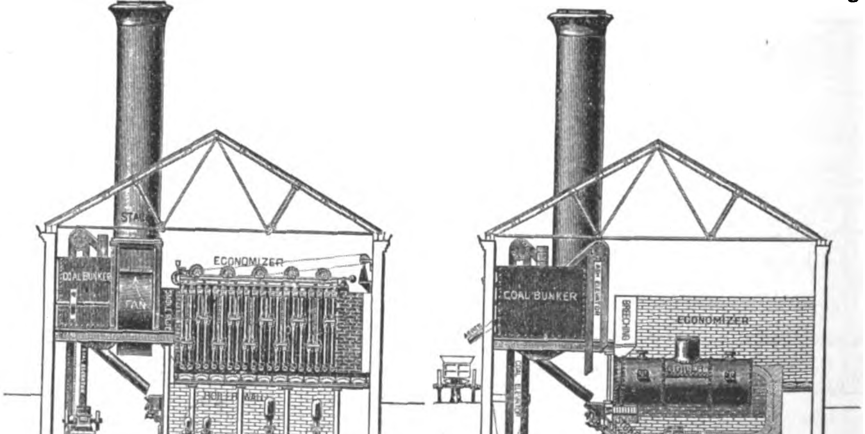


FIG. 6.—BOILER PLANT FITTED WITH FORCED DRAFT.

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Chimney draft, with 2,800 rated horse-power plant—		Mechanical draft with 2,600 rated horse-power plant—	
Cost as in Fig. 3.	$78,600	Cost as in Fig. 3.	$78,600
Cost of 2 additional boilers...	6,250	Cost of mechanical draft plant complete.	1,200
Settings, &c., for 2 boilers........	1,250	Saving in expense by mechanical draft plant	9,000
Cost of adding to building, &c	2,700		
	$88,800		$88,800

Such an increase in output as is here contemplated may be easily secured by mechanical means. It is evident that counting interest, insurance and taxes at 7 per cent on the investment, the annual fixed charges would be increased under chimney draft $714. In an economical arrangement this might cover the cost of operating the fan, if the exhaust steam should be thrown away. If, however, it should be utilized, as would be the case in any well arranged plant, this saving would be practically all clear gain.

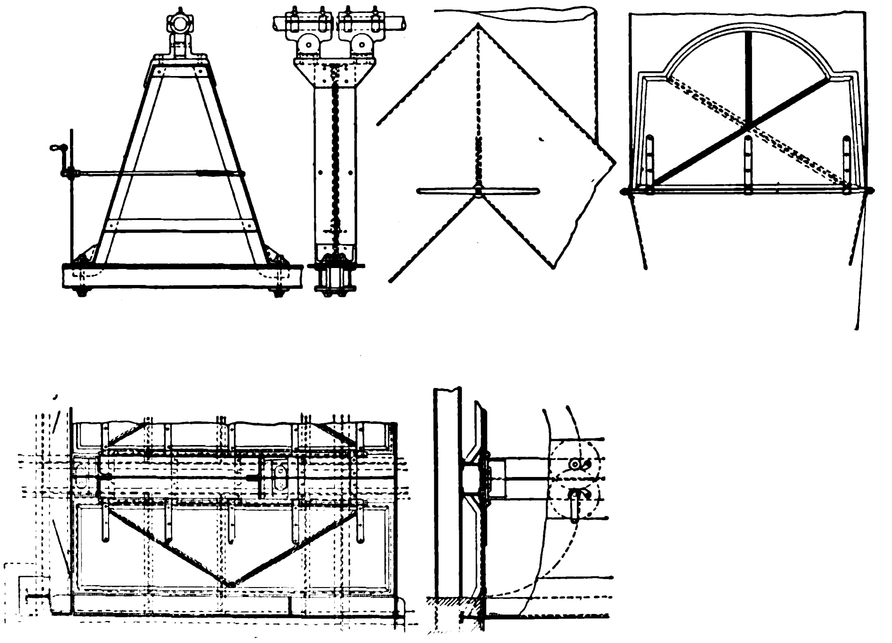


FIG. 7.—DETAILS OF DAMPER ARRANGEMENT, ELECTRIC RAILWAY PLANT.

The question of operating expense, which is the other factor in commercial efficiency, is most largely dependent upon the cost and character of the fuel; although the fixed charges are of only secondary importance. The value of a coal is not to be judged alone by its cost per ton, but by the number of available heat units which can be obtained for a given price. In this price should properly be included the transportation charges, the expense of getting the coal into the boiler house and putting it into the furnace, as well as taking out and carrying away the ash.

As the cost of transportation is practically dependent upon the weight and independent of the character of the coal, the proportional difference in price which may rule at the time may be almost extinguished when an equal charge is added for the transportation of each. Thus, a No. 2 buckwheat may prove an economical fuel at the mine where it may be purchased at 25 cents per ton. But its efficiency is so low that at a distance from the mine it may prove to cost more per 1000 lbs. of water evaporated than a coal costing considerably more per ton. As a rule, however, with proper appliances and mixtures, the low grade fuels may be made to show good financial results when burned with mechanical draft.

Based on the cost of the coal and the firing, the following will serve to illustrate the economy that may be secured by burning a cheaper fuel of lower efficiency. In a certain plant equipped with horizontal tubular boilers and down draft furnaces, an evaporation of 8.5 lbs. of water from and at 212 deg. was regularly obtained. The coal was Illinois slack, costing $1.40 delivered under the boilers. This makes the cost about 8.3 cents per 1000 lbs. evaporated under these conditions. Had the best picked anthracite coal, costing $4.80 per ton under existing market rates, been used, and had it evaporated the generous amount of 12 lbs. of water from and at 212 deg., the cost would have been 20 cents per 1000 lbs.

In another plant consisting of three water-tube boilers of an aggregate of about 1000 h.p., there was burned with chimney draft a coal costing $4.00 per ton delivered, and it was found impossible to burn a low grade fuel. Upon the application of mechanical forced draft, the fuel was changed to a mixture as indicated below. The result of thirteen weeks run, during which the average power developed was 1562.36 indicated h.p., was as follows:

	Weight in Lbs.	Cost.
Dry buckwheat coal containing an average of 17 per cent. of dust or anthracite culm that would pass through a 3-16-in. square mesh screen......	1,613,217	$2,019.91
Dry dust or anthracite culm.	287,781	215.48
Low grade Cumberland........	170,983	313.11
	2,071,891	$2,548.50

This covers all coal used for banking fires at night and getting up steam in the morning. The average cost per i.h.p. per hour is .21 of a cent. The average actual saving resulting from a change in fuel amounted to $126 per week, enough to pay for the fan and its engine in about six weeks.

Fig. 6 serves to show a duplex induced-draft apparatus, which was recently installed in connection with the boilers of an electric railway power plant. The two fans, each driven by an independent engine, are placed upon the top of a brick chamber to which the gases pass from the economizers. An arrangement of dampers similar to that shown in Fig. 5 serves to control the discharge of these gases. The plant as at present installed consists of only three boilers of 200 h.p. each, although the draft apparatus is designed for twice that number—the eventual size of the plant. Each fan is of sufficient capacity to operate the entire future plant. The expense of a tall chimney and expensive foundations which would have otherwise been necessary, was avoided by the employment of the fans in connection with a very short stack extending just above the roof. Under the circumstances the draft apparatus does not, of course, operate at its highest efficiency, for all three of the present boilers are seldom used. Nevertheless, the advantage of instant response to sudden demands has proved the greater advantage of the mechanical method.

The average results of operation during a single summer month are given in Table II. The plant is usually started up about 5.15 a.m., and stopped at 12.15 a.m.

TABLE II.

AVERAGE RESULTS OF ONE MONTHS' RUN OF ELECTRIC RAILWAY STEAM PLANT.

Items.		Average for month.
Total time in operation	hours	569
Total coal consumed..........	pounds	415 591
Total ash....................	"	30,897
Total combustible consumed. 1	"	384,694
Average coal consumed per hour...........	"	730.4
Total water pumped into boilers......	"	4,150,672.4
Average water pumped into boilers per hour	"	7,294.7
Average water pumped into boilers per pound of coal consumed.	"	9.99
Average temperature of water entering economizer....	degs. F.	208.
Average temperature of water entering boiler.......... . ..	"	242.7
Total electrical output	watts	154,165,(00
Average electrical output per hour	"	270,900
Equivalent electrical horse-power per hour.... . ..	"	363.1
Average coal per electrical horse-power per hour.....	pounds	2.12

In addition to the general economic advantages of mechanical draft which have been presented, there are those which relate primarily to the convenience of installation and operation. Prominent among these is the feature of adaptability. The fan, which is usually of steel plate, may be constructed in any shape to meet specific requirements; may be located as desired with regard to the position of the boilers and without expensive foundations; may be used for either forced or induced draft; and because of its portability may be relocated or exchanged for another of different capacity. In its operation the fan is perfectly flexible, may be run at high or low speed, independently of the chimney temperature, and is always susceptible of instantaneous change in response to sudden demands. A mere change in engine cut-off produces an effect only secured with a chimney by adding to its height at great expense.

External temperature changes have no appreciable effect upon the operation of mechanical draft, which, above all else, is independent of climatic conditions. The fan is a most important factor in smoke prevention, its value under such conditions being that which is due to the ability to continue the operation of a boiler plant when, without smoke prevention, its operation under stringent laws would have been impossible.

Briefly summarized, mechanical draft has here been shown to be capable of reducing the avoidable losses, of decreasing the first cost of a steam generating plant and of reducing the fuel expense. In addition, it presents certain marked conveniences in the matter of installation and operation.

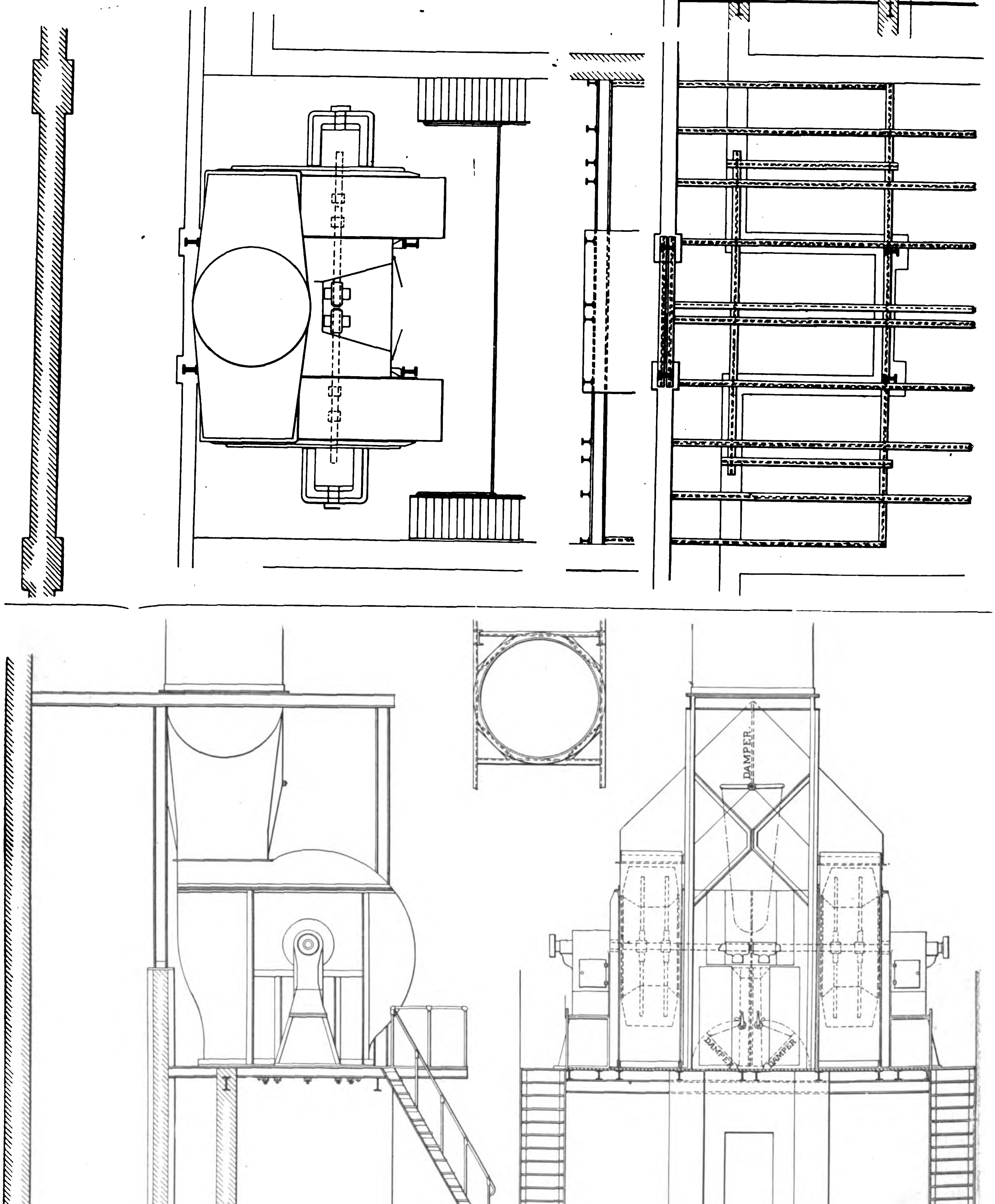


FIG. 8.—DUPLEX INDUCED DRAFT PLANT FOR ELECTRIC RAILWAY SERVICE.

In these days, when every step in the process of steam generation and utilization is being scrutinized in the attempt to reduce the cost by even a single per cent, the opportunity presented by the employment of mechanical draft cannot be, and is not, overlooked. The economical necessity was not so great a quarter of a century ago, when its advantages were first definitely realized by thoughtful engineers. And the future was first dimly discerned when, only fifteen years ago, Seaton referred to the chimney as a rough and ready but exceedingly wasteful way of inducing the air to flow into furnaces with sufficient velocity to cause the fuel to burn, and prophesied that it would some day be superseded by a more scientific and economical device.

THE 220-VOLT SYSTEM.

220-VOLT AND ALTERNATING CURRENT SYSTEMS.

BY PROF. GEO. D. SHEPARDSON.

In the last few years a large number of plants have been installed for lighting by incandescent lamps at 220 volts. Although the reasons for and against the use of high voltage lamps have been discussed to some extent in various papers, there seems to be some uncertainty as to whether it really pays to use the 220-volt lamps as made at present. This is a question that has two sides, and the present writer does not hope or intend to settle the question, but simply aims to clear up some hazy ideas that seem to be prevalent.

In brief, the main argument in favor of the use of higher voltages is the great saving in copper required in the wires and the greater distances that may be reached. The various points will be considered in detail later in the paper.

First, consider why less copper is required as the voltage rises, by simple calculations for a common case. Suppose that it is desired to transmit 10,000 watts to a point 1000 ft. distant with a loss on the line of 10 per cent. Calculate the size of wire and the weight of copper required for different voltages.

Suppose the energy is to be delivered at 100 volts; since the energy equals the product of current by pressure, the current may be obtained by dividing watts by volts; whence current is 10,000 divided by 100, or 100 amps. The resistance of the line is found by dividing the drop on the line by the current; the loss is to be 10 per cent, or 10 volts; whence the resistance is 10 divided by 100, or 0.1 ohms; since the total distance out and back is 2000 ft.. the wire must have a resistance of half the above, or 0.05 ohms per 1000 ft.; reference to a wire table shows that the nearest size wire is No. 0000, having a resistance of 0.049 ohms per 1000 ft. The table also shows that 2000 ft. of this wire weighs 1240 lbs. if bare, or 1460 lbs. if covered with "weather-proof" insulation.

Next try the effect of raising the voltage to 110 volts instead of 100. Following the same method of calculation as above, the current is found to be 91 amps., the drop on the line 11 volts. Size of wire No. 000, weighing 1014 lbs. if bare, or 1176 if weather-proof. It is thus seen that by using lamps at 110 volts instead of at 100 volts, the same amount of energy can be delivered with the same loss on the line, although the weight of copper used in the line is 226 lbs. less if bare, or 284 lbs. less if weather-proof insulated. In other words, by raising the voltage 10 per cent we have saved 18.3 or 19.5 per cent of the copper. This is on the assumption, of course, that the lamps in the second case are suitable for the higher voltage and are of equal efficiency.

By sending directly to the lamp makers we could even get lamps for 120 volts equally as good and efficient as those for 100 volts, so let us see what saving would be effected by using 120 volts at the point of delivery. The current is 10,000 divided by 120, or 83.5 amps.; the drop on the line is 10 per cent of 120, or 12 volts; the resistance is 12 divided by 83.5, or 0.144 ohms, which requires No. 00 wire. This will weigh 804 lbs. bare, or 952 lbs. weather-proof. By using 120 volts instead of 100, we have thus saved the necesity of buying and erecting 32 per cent of the bare copper, or 35 per cent of the insulated wire.

If so much copper can be saved by increasing the voltage only 10 or 20 per cent, the question at once arises, Why not boldly double the voltage, or even go even higher? Hopkinson, Edison and others answered the question by evolving the "three-wire system," which is practically two two-wire systems coupled in series so that the common wire is the positive side of one and the negative side of the other. The voltage between the two outside wires is thus twice that of either dynamo and the energy is transmitted at double the voltage of either. By the use of the common or "neutral" wire, the lamps on each side get their proper current at the proper voltage as if the other side were not in existence. The three-wire system requires three wires and two dynamos, and moreover is or has been controlled by one company. Competitors have been driven to some substitute or else pay royalty. The two competitive methods are the 220 two-wire and the high-tension alternating system.

Consider the saving of copper effected by the three-wire 110-volt or the two-wire 220-volt system, as compared with the 100-volt.

For delivering 10,000 watts at a point 1000 ft. distant with 10 per cent loss as before, but using 220 volts, the current is 45.5 amps.; the drop is 22 volts; the resistance of the wire is 22 divided by 45.5, or 0.484 ohms; this requires a No. 4 wire, which weighs 250 lbs. bare, or 320 lbs. insulated. This means a saving of 988 lbs. bare, or 1140 lbs. insulated; or 79.7 per cent bare, or 78 per cent insulated, as compared with the 100 volt system. Comparing it with the 110 volt system we have a saving of 762 lbs., or 75 per cent of the bare wire, or 856 lbs., or 73 per cent of the insulated wire.

For the three-wire system there is required a third wire that is either the same size as the outers or one-half their size, according as it is one of the distributing mains or one of the feeders. The principal objection to the 220-volt two-wire system is that the 220-volt incandescent lamp requires more energy for the same amount of light than does the 110-volt lamp.

The principal competitor of the systems named above is the alternating current system using high potentials for transmission and transformers which reduce the voltage for distribution and use. The voltage commonly used for transmission has usually been about 1100 volts for transmission and 110 volts for distribution. To compare the amount of copper required for transmission at 110 and at 1100 volts, we may calculate as in the preceding examples. Ten thousand watts would mean 9.1 amps. at 1100 volts; 10 per cent loss would mean 110 volts; to carry 9.1 amps. 1000 feet and back with a loss of 110 volts requires a line with a resistance of 12.1 ohms, which would be a No. 18 wire; this would weigh 10 lbs. bare or 22 lbs. weather-proof. Thus by transmitting at 1100 volts with the same loss as with 110 volts, we save 1004 lbs., or 98 per cent. of the wire if bare, or 1156 lbs. or 98.1 per cent of the wire if weather-proof. As good engineering practice would not allow any wire smaller than No. 10 to be used for pole line work, unless hard-drawn, we would not use the small wire indicated. Calculating the loss incurred when using the No. 10 wire, we find that it has a resistance of 1.0 ohm per 1000 ft.; therefore, the resistance of the line would be 2.0 ohms, the drop would be the product of current by resistance, or 2.0 multiplied by 9.1, or 18.2 volts; which is 1.63 per cent of the 1100 volts. Allowing 5 per cent loss in the transformer, we still have 3.4 per cent loss in favor of the alternating system. The weight of the No. 10 wire would be 63 lbs. bare or 102 lbs. weather-proof insulated.

Combining the above results in a table for easier reference, we have:

WIRE FOR DELIVERING 10,000 WATTS 1,000 FEET AT 10 PER CENT LOSS.

Volts delivered	Size wire.	Weight of wire.	
		Bare.	Weather-proof.
100	0000	1240	1460
110	000	1014	1176
120	00	804	952
220	4	252	320
1100	18	10	22
1100	10	63	102

From the above case it is seen that the saving in wire required by the 1100-volt transmission would more than pay for the transformers, when compared with the 110- or 120-volt system, and would go far toward it when compared with the 220-volt system. When the distances approach a mile or more, the comparison is far more in favor of the alternating system.

Having now seen why engineers prefer to use high voltages when possible, let us note the arguments advanced for and against the 220-volt system by its advocates and opponents, without vouching for their accuracy.

Comparing the 220 with the 110-volt system, we hear:

(1) Less copper is required.

(2) Greater distances are within practical reach; hence

(3) The power plant may be in a more convenient location, and

(4) A larger district may be covered and more business obtained.

(5) The lamps are stronger, being about 20 c.p. instead of 16.

(6) The lamps give more steady light; hence

(7) The customers are better satisfied.

(8) The lamps do not blacken so much as 110-volt lamps.

(9) The lamps last longer; and hence

(10) The customers are still better satisfied and take more lights.

Comparing with the three-wire system, we hear:

(11) The wiring is simpler.

(12) There is no trouble from unbalanced load.

(13) The neutral wire being omitted, means less copper required.

(14) Only one dynamo is required instead of two; hence

(15) The first cost of machine is less; also

(16) The dynamo is more efficient than two smaller ones of equal aggregate capacity; also

(17) Less space is required in the power house; and

(18) The one machine requies less attention and less repairs than the two.

(19) The system is not controlled by one company; hence

(20) The purchaser has the benefit of competition and lower prices.

(21) Arguments 5, 6, 7, 8, 9 and 10 hold equally true here.

Comparing with the alternating system, we hear:

(22) All the 220-volt plants claim to be making money, while most of the alternating current plants claim to be losing continually, having never paid expenses, etc.

(23) The 220-volt system gives better regulation; hence

(24) The light is better; hence

(25) Better satisfaction is given both to owner and to customers; hence

(26) The business builds itself up.

(27) The lamps do not blacken as with alternating (or direct) 110-volt.

(28) The lamps give more light, being more nearly 20 c.p. than 16.

(29) Arc lamps may be used indoors where alternating current arc lamps would be intolerable on account of their noise.

(30) Storage batteries may be charged without being taken to the power house.

(31) Motors of any size and of high efficiency may be operated without difficulty.

(32) The system of distribution is simpler.

(33) No loss in transformers.

(34) No extensive transformer repairs.

(35) Less trouble from lightning.

(36) Less danger from fire.

(37) No danger from shocks from high potential circuits.

(38) The all-day efficiency is higher; that is, the total watt hours delivered to customers is more nearly the total watt hours developed at the power house.

(39) If meters ars used, the low efficiency of the 220-volt lamp does not work against the central station man, since he gets paid by the watt-hour, and not by the lamp-hour.

(40) Bare wire may be user for pole lines in prairie towns and on streets without trees, thus saving much expense for insulation. The practice of running bare wires through the streets would not be allowable with high tension alternating currents. Hence a saving not only in first cost, but also in maintenance; hence, also,

(41) The wires on the poles always look well, not having any decaying insulation hanging from the wires.

(42) The 220-volt plants are simpler, hence less trouble to run; and

(43) Less expert help is required.

(44) One can always test his plant for efficiency without such uncertain elements as angle of lag, power factor, etc.

(45) There is no induction to disturb telephone circuits.

(46) The 220-volt dynamo may be coupled directly to the engine, thus avoiding the loss of from 2 to 5 per cent in the belting, which is nearly always used with alternators, except those of very large size. This saving largely offsets the lower efficiency of the 220-volt lamps.

Against the 220-volt system we hear other arguments, some of which are as follows:

(1) The 220-volt lamps are of low efficiency, requiring 55 to 80 watts when new, as against 45 to 60 watts for 110-volt lamps.

(2) The 220-volt lamps rapidly drop off in candle power.

(3) They gradually take more and more current; consequently

(4) The unproductive load becomes greater if charging by the lamp hour or flat rate by the month; or

(5) The load quickly increases beyond the capacity of the plant.

(6) On account of the low efficiency of the 220-volt lamps, the lines will have larger drop than calculated; hence

(7) The watts lost on the line will be greater, or

(8) The lines must be larger for the same number of lamps on account of their inefficiency, thus losing a considerable part of the benefit from the higher voltage.

(9) On the same account, the dynamo and engine must be larger for the same lamp capacity.

(10) This increases the first cost of engine and dynamo from 10 to 20 per cent.

(11) The larger amount of energy demanded by the inefficient lamps requires the consumption of more coal.

(12) Any improvement in the 220-volt lamp must be equally applicable to the 110-volt lamp, so that the balance must continue to be against the 220-volt lamp.

(13) The 220-volt lamp costs about 25 per cent more than the 110-volt.

(14) The switches and other fittings must be special or extra good.

(15) The filaments of the 220-volt lamps are so slender that they cannot be used in a horizontal or inclined position without great risk of the filament drooping over and touching the glass bulb, thus breaking the lamp.

(16) The lamps cannot be used with key sockets with drop cords, for the filaments are liable to bend over and touch the glass when turning off the key.

(17) Many of the lamps explode when first put into service; thus

(18) Frightening the user and

(19) Causing increased cost for renewals.

(20) The 220-volt system is not so suitable for arc lamps as the 110-volt direct or alternating system, since four or more lamps must be run in series for economy.

(21) Four arc lamps in series on a constant potential circuit area are a source of constant trouble both to user and to station man.

(22) It is not practicable to use a single arc lamp on a 220-volt system without using an "enclosed arc."

(23) The enclosed arcs are not satisfactory for 220-volt circuits, since the current is so small that the largest part of the light comes from the arc rather than from the carbons, thus making a violet tinge that is not agreeable.

(24) It is not practicable at present to get an enclosed arc light of more than 1200 nominal c.p., which is too small for some purposes.

(25) It is not so easy to arrange incandescent street lights for economical operation from a 220-volt system as with the series alternating.

(26) A street incandescent system requires far more copper than a series alternating system.

(27) With street incandescent lamps on the 220-volt multiple arc system, it is not easy for the station operator to tell whether all his street lamps are burning, as it is with the series alternating with lamp board and ammeter.

(28) Stations equipped with modern alternating current apparatus are operating very efficiently, more so than the 220-volt plants, and are also making good earnings.

(29) A town can be equipped with an alternating current plant for less money than with a 220-volt plant, if the town is scattering, or is at some distance from the source of power.

The writer disclaims all responsibility for the truth of the arguments detailed above, but gives them as those used by the advocates of the different systems. He believes they are all true so far as they go, but his experience does not fully cover arguments 8 and 10 for the 220-volt system, or arguments 23 and 24 against.

Some remarks may well be added concerning some of the arguments. Of those for the 220-volt system, we may note that the truth of 5 and 28 depends upon the make of the lamps. The 220-volt lamps of two prominent makers give nearly 20 c.p., although marked 16; those of some other companies are about 16, some being as low as 13 c.p. when new. All of these drop off as they burn, so that in a few hundred hours they are no stronger than 110-volt lamps of the same age and rating.

The better regulation claimed in argument 23 for the 220-volt system should be taken with allowance when applied to well engineered modern plants. The noise of alternating current arc lamps mentioned in argument 19 is greatly reduced if the globe fits tightly against the lamp case so as to hold in the noise. With enclosed alternating current arc lamps the noise is hardly noticeable.

The difficulty of charging storage batteries from alternating current lines may sometimes be of importance, yet this difficulty is removed by the use of a rotary transformer. Small batteries may be taken to the power house and charged by the exciter. The alternating current has a compensating advantage in that it is possible to increase the volume of the current indefinitely by the use of a transformer which will reduce the voltage proportionally. Conversely, it is easy to get a very high voltage by the use of a "step-up" transformer.

Motors may be operated with success from a two-phase, or "monocyclic," or three-phase plant. In fact, for transmission of any considerable amount of power the alternating current is conceded to have no superior. For small motors, the ordinary single-phase current is quite satisfactory.

The loss in transformers and the necessary repairs from lightning and other burnouts is greatly reduced by the modern methods of construction and operation.

The troubles of the telephone man are by no means all traceable to induction from alternating currents. He can neutralize such induction by careful arrangement and maintenance of his lines. In one city known to the writer, most of the telephone troubles from other currents come from direct current plants that make some use of the ground in common with the telephones.

Referring to some of the arguments against the 220-volt system, we may note in connection with objections 9, 10 and 11 that the great saving in the investment of copper for feeders may more than balance the added cost of engine and dynamo and may also reduce the annual added cost of coal. The higher first cost of the 220-volt lamp is more than compensated by its longer life, although the high mortality in infancy (if we may so term the premature explosions that used to be more common than now) may offset this. The difficulty of the filaments touching the glass when lamps are used in horizontal or inclined positions may be diminished by so turning the lamp that the plane of the loop is vertical, in which position it is stiffer. Better methods of anchoring the filament have also reduced this trouble.

One of the great advantages of the alternating system is the ease of raising or lowering the voltage by the use of adjustable transformers or boosters. To be sure, the motor and dynamo combination usuallv known by the same term accomplishes similar results, but at the cost of two moving armatures with the attendant care and expense.

Attention might be called to another point that is sometimes mentioned by advocates of the 220-volt system, "but secretly, for fear of the Jews"—namely, that the efficiency of the direct current 220-volt dynamo is higher than that of the alternating current machine. This may be true when comparison is made with the alternators of years ago, but hardly so with the late ones. Records of tests of recent alternating and direct current generators of equal output made by the same company show that for sizes above 50 k.w. the efficiencies of the two types of machine are practically the same. With the smaller machines the inefficiency of the small exciter has a larger effect and the total efficiency of alternator and exciter is slightly less than that of the self-excited direct current generator. The cost of machines of the same maker is also practically the same, except also that in the smaller sizes the exciter raises the cost of the alternator slightly.

W. I. Gray & Company, of Minneapolis, have kindly furnished the following figures showing the relative cost of certain plants upon which they have made bids for both alternating and 220-volt specifications. There is some uncertainty as to the exact basis upon which the specifications were drawn so far as relates to the calculated losses on the lines, but it seems fair to presume that they were upon the same basis in each case, so far as practicable.

For one plant with 60 k.w. machine, about 3600 ft. from the center of distribution, the bid for alternating system was $5100, while that for 220-volt was $5742, with belted generator, and $6242 with direct connected 220-volt generator. In this case, there was a difference of over 3000 lbs. of copper in the feeders alone.

Upon another and smaller plant in which the power house was 2000 ft. from the center of distribution, the bid for alternating system was $2195, as against $2435 for the 220-volt.

At another letting their bid for 220-volt system was $3396, while their two bids for alternating systems, not covering quite the same ground, however, were $3340 and $2858. Comparing two cases nearly alike, the wire for the 220-volt came to $1359, while the wire for alternating lines was estimated at $715, to which should be added about $380 for transformers, or a total of $1.095 compared with $1,359.

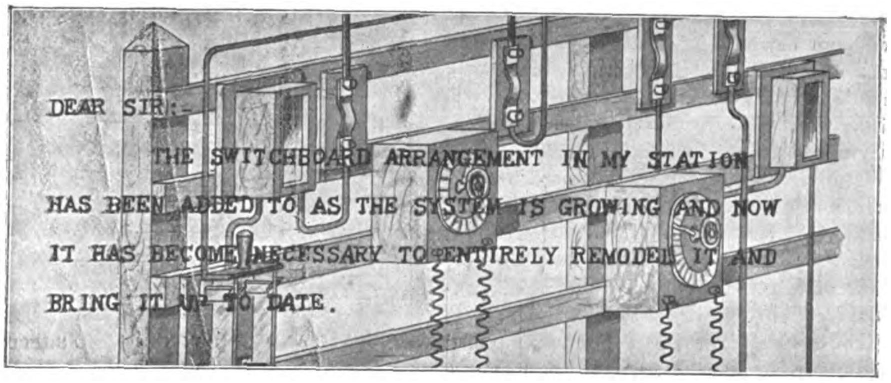
At another letting the bids of various parties for 220-volt plants were $9800, $9300, $9400, $9240 and $8485. The contract was let for an alternating system at a figure between $7500 and $8000.

The above figures are all exclusive of steam plant and building. They seem to indicate that for equally well made apparatus, the alternating systems are cheaper in first cost.

In the face of all that precedes, it should be remembered that a large number of 220-volt plants have been sold and are operating very satisfactorily. Moreover, they seem to be paying excellent dividends.

SWITCHBOARD RECONSTRUCTION.

BY ALBERT B. HERRICK.



DEAR SIR:—

THE SWITCHBOARD ARRANGEMENT IN MY STATION HAS BEEN ADDED TO AS THE SYSTEM IS GROWING AND NOW IT HAS BECOME NECESSARY TO ENTIRELY REMODEL IT AND BRING IT UP TO DATE.

The above is a type of letter I receive very often. The salient features and modern methods adopted in switchboard construction may be of general interest.

Where radical reconstruction is undertaken it should be borne in mind that it does not necessarily follow that the best position for the new board is where the old one was located.

In a small station where the engineer is also the dynamo tender, the valve of the engine, the commutator of the dynamo and the dynamo regulator and switch, should be so arranged that the engineer does not have to pass near moving belts or squeeze by the engine in order to reach them; in short, do not place the attendant under physical hazard if the right thing is to be done under all conditions of service.

The materials used in switchboard construction should necessarily be fireproof, as the conductors leading to the switchboard are covered with semi-inflammable material makes the switchboard a center to which fire will naturally travel.

Materials of a fireproof nature should be used for the support and insulation of the instruments and busbars. The skeleton frame of wood even when covered with asbestos paper or filled with the so-called fireproofing compounds has not been found to reduce the fire hazard enough to make their use advisable. Slate and marble slabs and iron verticals cost only slightly more, and insure a good mechanical and absolutely fireproof construction.

The use of slate and marble for this work would be universal if the constructor knew how easy it was to handle and drill the slabs. First, the switchboard is laid out and divided into slabs not larger than 4 ft. x 2 ft., as they are more awkward to handle and more liable to break when of larger size. In laying out, do not place the apparatus so that a number of holes for their support come on the same straight line, as the least pressure will crack the slab through this line of holes. If it is necessary to break the slab, the best way to do it is to drill a number of holes along the line of required fracture and then, by driving in taper iron plugs, the slate can be fractured.

The slate can be drilled by a twist or flat drill run at a slow speed, but be careful not to let it choke up with dust. Where the proper sized drills are not at hand, use a gaspipe having the outside diameter the same as that of the hole required, and file a set of teeth on one end of the pipe; if this is rotated slowly and fed emery powder and water, it will quickly cut a hole through the slate or marble. Always provide a support directly under the hole which is being drilled, so that no traverse strains are supported by the slate.

In the selection of slate, the uniformly colored brown or dark gray having a clean fracture will afford, as a rule, a good insulation; while the variegated variety and those having strong veins and metallic blotches should be carefully tested for their insulating qualities.

The supporting of the slate and marble boards are best done by steel angle or channel verticals. Figs. 1 and 2 show some of the methods of supporting. These slabs can be bolted directly to the verticals, but the precaution should be used to have washers between the slate and steel member at the points of support, so the slate will not be made to conform to a warped or irregular surface. Do not have these verticals carry any compression strains, as they often tend to bow, throwing an abnormal strain on the slate surface.

The bottom of the switchboard can be either on foot plates 16 ins. or 18 ins. high, or supported on pillars. There are split pillars made which surround the iron vertical, thus giving it a very neat and inexpensive finish.

The iron framework of the switchboard should be insulated from the ground where held on a cement or structural iron floor and in high tension switchboards this becomes very necessary. Fig. 3 shows one method where the vertical has an insulated footing on an iron floor member. Stone pedestals can be set in cement when this is used as flooring. This framework should also be insulated from the wall, which can be done by means of the insulated coupling and turnbuckle shown in Fig. 4.

The best location of the board is largely a matter of local conditions, and it is often advisable to use some of the later day appliances and instruments from the old board in the reconstructed switchboard, which will again modify the plans. The rheostat should have the preference as regards location, as it should be easily adjusted when the attendant stands in front of the board and can see the dynamo ammeter and voltmeter.

The ordinary practice is to arrange the dynamo switch at the bottom of the board, then the rheostat, then the voltmeter or dynamo galvanometer switch, then the amperemeter in the same vertical line for each generator.

The connecting together of the apparatus electrically should be done on the back of the board and following the above method of arrangement of apparatus gives the vertical method, the only horizontals being the busbars.

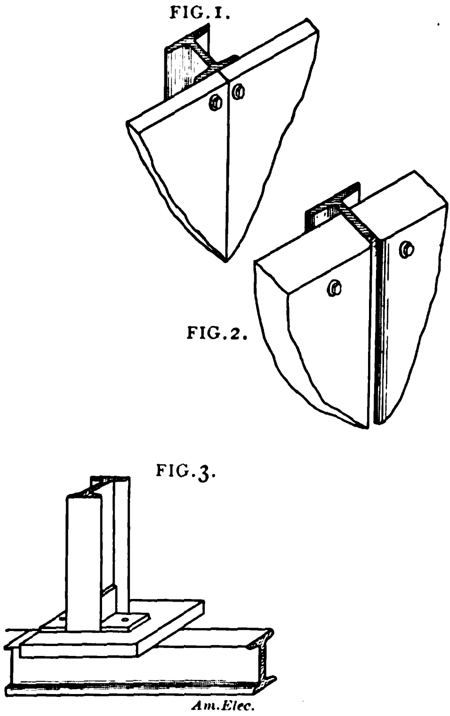
Where face connection switches have been used, these can be made into back-connecting switches when they are refinished, by drilling out the hole provided for the lug and tapping this out for a copper stud with a shoulder, and fitting it with a threaded nut on the front. This makes a stud connection like that shown in Fig. 5.

Where two copper conductors are secured together, use iron bolts and nuts for securing them, for the reason that when the conductors heat they expand faster than the bolts holding them, and thus increases the contact pressure and reduces the contact resistance.

FIG. 1.

FIG. 2.

FIG. 3.



FIGS. 1, 2 AND 3.—SWITCHBOARD SUPPORTS.

So far the constructional features have been common to both high and low-tension switchboards. The low-tension board will be taken up in those details especially pertaining to its construction. The busbars and vertical connections can be bare copper rods or bars if they are arranged so that each potential is on a separate vertical plane, making an accidental short circuit impossible. These busbars can be supported and insulated on cast iron brackets secured to the vertical iron members and pieces of marble placed on the bearing surfaces for insulation. Some of this construction is shown in Fig. 7, where a number of buses are used in multiple, and in Fig. 8, where only one bus is to be erected.

In low-tension work, where the current volume is large, the making of contact where the different conductors are to be connected together is one of importance, but the element of the truth of the surfaces in contact and the pressure of contact both play a very important part, as well as the metals that are brought together. Copper bus to copper bus, and 180 to 200 amps. per square inch in general practice. A thread with a nut forced on it which has a good fit will carry 160 amps. per square inch of thread area. A cable soldered into a lug if well soldered will carry 160 amps. per square inch. Switch blades carry, at a fair rating, 60 amps. per square inch available contact area. Commercial brass has about 22 per cent of the conductivity of copper. A copper busbar table is given below.

It is generally the aim in assembling to give the front of the board an appearance of neatness, but the backs of some of the boards I have come across are unfathomable mysteries in the maze of their connections. The back connections can be laid out with just the same simplicity as the front, if time is taken to make a creditable job. In order that the connections can be followed, it is usually the practice to carry all the positive connections to the right and above.

In three-wire work the neutral system is sometimes connected together at the dynamo, and a common neutral brought up for the feeders. This reduces the switches on the switchboard and saves one-half the weight of copper in the dynamo leads.

The equalizer in railway and isolated plants is often permanently connected at the dynamos, saving one-third, approximately, in weight of copper.

The ground returns run directly to the negative bus in this case, the positive or trolley bus only being connected to the feeders through the switch and circuit breakers.

In re-designing switchboards, it is often desirable in order to cover an expanding territory with the low-tension system, to supply feeders with different potentials during different periods of the load to compensate for the feeder losses, which may be due to too little copper or too great distance. If too little copper, the investment in further copper would probably be dictated by economical considerations, and the maintenance of the maximum economy of generation by still maintaining one potential. These matters are foreign to the present topic, but are touched on in order to show that to increase the bus potential of a constant potential system always increases the losses of that system and neutralizes the maximum station economy, which occurs at the same period, and these questions become very pertinent when re-designing the switchboard to cover future developments.

For two potentials double-throw switches can be used, which can be all thrown on the common bus when the current density on the copper system is too low; and the feeders can be thrown on the high potential bus when the loss in pressure is such that they cannot deliver the current at normal voltage at the mains.

A three-potential system can be devised by using a double-throw switch only, if the common bus is the one carrying the mean pressure; and by then grouping the inlaying, mean and outlaying feeders into three groups, they can be connected as shown in Fig. 9. This of course requires that three different potentials be delivered by dynamos or boosters; the dynamo board in this case would have to be provided with a three-way switch, which is generally made up of two double-pole double-throw switches.

Sometimes long isolated feeders are supplied with equalizers, or lamps of lower voltages are used on this service; but for general regulation of pressure, equalizers have long since been abandoned and more copper laid down to reduce the unbalanced pressure on the mains.

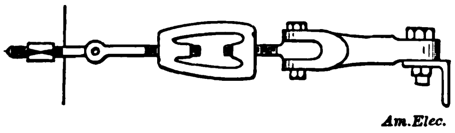
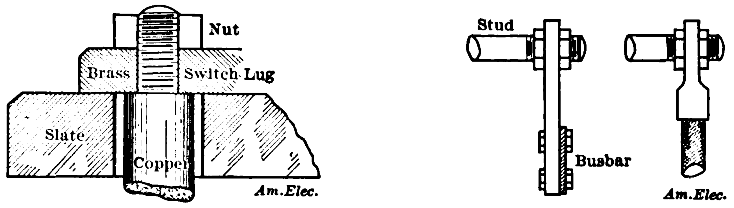


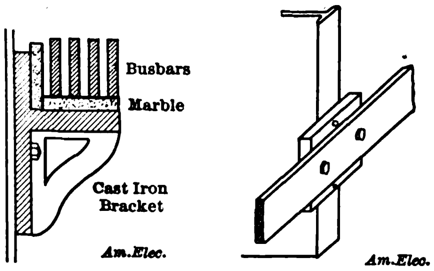
FIG. 4.—INSULATED COUPLING AND TURNBUCKLE.



FIGS. 5 AND 6.—STUD CONNECTIONS.

Copper Bar Data.

Size.	Amperes.	Circular Mils.	Square Mils.	Ohms per Foot.	Weight per Foot.
1" x ¼"	433	318,310	250,000	0000336	.97
1¼" x ¼"	530	397,290	312,000	.0000269	1.21
1½" x ¼"	626	477,465	375,000	.0000233	1.45
1¾" x ¼"	725	556,400	437,500	.0000192	1.70
1¼" x ⅜"	676	596,830	468,750	.0000179	1.82
1½" x ⅜"	798	716,200	562,500	.0000149	2.18
1¾" x ⅜"	916	835,600	656,250	.0000128	2.54
2 x ⅜"	1,035	954,930	750,000	.0000112	2.92
2¼" x ⅜"	1,154	1,074,300	843,750	.00000995	3.27
2½" x ½"	1,500	1,591,550	1,250,000	.00000672	8.86
2½" x ⅝"	1,715	1,939,440	1,562,500	.00000537	6.07
2" x ½"	1,222	1,273,240	1,000,000	.00000840	3.89
No. 0000 B & S	257	211,600	....	.0000505	.64
½" Round	305	250,000	....	.0000428	.76
⅝" "	426	390,625	....	.0000273	1.18
¾" "	560	562,500	....	.0000190	1.71
1" "	861	1,000,000	....	.0000107	3.05



FIGS. 7 AND 8.—BUSES.

In order to determine the pressure on the mains, pressure wires are brought back to the station and connected to a pressure switch, and the pressure at the mains in this way compared either with the bus bar pressure for losses or a standard pressure for regulation. This switch places across the pressure arms from each feeder the voltmeter terminals. It is generally desirable to have a voltmeter for the standard feeder permanently connected in, and a separate voltmeter for feeder pressure. If the feeder pressure switch is conveniently located, enough additional terminals can be added for the dynamos, and it can also be used with the same voltmeter for throwing the dynamos on the system, in this way saving the investment of a dynamo pressure switch and dynamo galvanometer.

The field rheostat or regulator being mounted on the switchboard, requires that one leg of the field be brought from the generator to the switchboard; the other leg can be connected to the dynamo side of the dynamo switch, if self-excited, and the busbar side, if separately excited.

The dynamo can also be independently excited, and of the different methods the best to adopt depends entirely upon local and distribution conditions as they all have their friends. Another wrinkle is to so have all fields that they can normally be self-excited, and also independently excited from a separate generator, which normally operates on the system. The reason of this is that when a dead short comes on, the shunt generator flunks and refuses to maintain the potential to burn out the short circuit, and the field rheostats have resistance all out to make them deliver enough current to burn out the short circuit; when this does let go, the potential takes a jump that is liable to break the lamps. When this occasion does arise, it is very easy, where a double-throw switch is placed on the board, for each generator, to open the field wire and throw over and feed the field from an idle generator; in this way the excitation is independent of the armature reaction and all the generators can be held up to their load and be controlled by one rheostat.

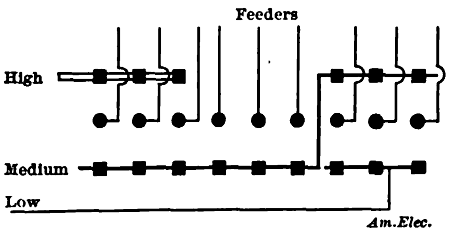


FIG. 9.—THREE-POTENTIAL FEEDERS.

There are a number of other useful adjuncts, such as pilot lamps for generators, alarms for open circuit breakers. In the case of compound generators where the equalizer is operated by a switch at the generator, if this is left open when the generator is thrown on the circuit, trouble will arise. A good practice is to have a double-pole switch at the generator, and to bring the equalizer, as well as one leg of the circuit, through this switch so the generator cannot be thrown in until this switch is closed.

In the three-wire system any dynamo can be used on either side of the system by means of a double-throw switch on the switchboard. Where the dynamo is also compound, the equalizer must also be brought to the switchboard and a triple-pole double-throw switch used.

Where an equalizer is brought into a switch used also for a dynamo switch, the terminal from the equalizer clips should be a trifle longer than the other clips, that the dynamo may be equalized before it is thrown on the system.

The reading of amperes at stated intervals and multiplying the average by the voltage does not give a figure in watts output which is reliable enough to figure the economy of the plant operation from. An integrating wattmeter inserted in the main bus, generally between the dynamo and feeder board, is very desirable where accurate records are to be kept.

Arc light switchboards involve but very little variation, and experience has shown that a flexible cable having its end terminating in plugs by means of which the different circuits are connected, gives the best satisfaction.

In the construction of these boards marble and slate should not be depended on, as the insulation for the terminals of the board at this point should be reinforced by, preferably, micanite or built-up mica. All bare conductors should be heavily taped or have glass or hard rubber tubes fitted or slipped over them, so the flaming arc which occurs when these circuits of 4000 volts is pulled, will not flare up and start a general flashing behind the board.

No matter how well the framework of the board or the flexible conductors are insulated, have a rubber mat or insulated flooring in front of the switchboard for the attendant to stand on.

Lightning arresters are sometimes placed on these boards, but it is not the proper place for them; they should be connected to the circuit on its entrance to the building and choke the discharge off to ground at this point, if possible.

Ground detectors and testing arrangements are generally also arranged on the arc light boards so that the circuits may be tested out each day for opens and grounds.

An ammeter should be provided for each circuit, and also polarity indicators, so that if the lamps are burning upside down the matter may be rectified, as the lighting of the heavens is not as a rule satisfactory to the city fathers.

UNDERGROUND DISTRIBUTION.

EUROPEAN METHODS OF UNDERGROUND DISTRIBUTION.

BY FRANCIS JEHL.

European electric light engineers, and especially those living in Germany, Austria or Hungary, often wonder why the Americans and the English employ and build such expensive underground subways, conduits, etc., into which to place their electric light mains and cables. Mr. E. de Fodor, one of the directors and chief engineers of the "Budapester Allgemeine Elektricitats Actien-Gesellschaft," and which company has about 270 kilometers of double armored cable simply buried in ditches, said to the writer some time ago: "It seems to me that Americans invest too much money and time in underground conduits and the like, and too little on cables. You build wooden conduits, iron pipe conduits, cement lined pipes, terra cotta ducts, brick subways, and, in fact, every Tom, Dick and Harry has a system of his own. You have over there perfected conduits, and we on this side have improved our cables to such a standard that we have found it sufficient to simply employ the old Edison method — that is, simply lay the armored cable in a ditch, giving it a good bed of washed sand, on the top of which common bricks are laid, which are a sufficient safeguard against picks, etc. By spending a little more money on insulation and armor such a cable does away with all kinds of ducts, etc., and as the protection and insulation is executed at the cable works, it is self-evident that it can be better performed there than work that is done in a street, as when building conduits. Besides, the protection and insulation of an armored cables takes up but a minimum amount of space as compared with the space occupied by a subway and its accessories."

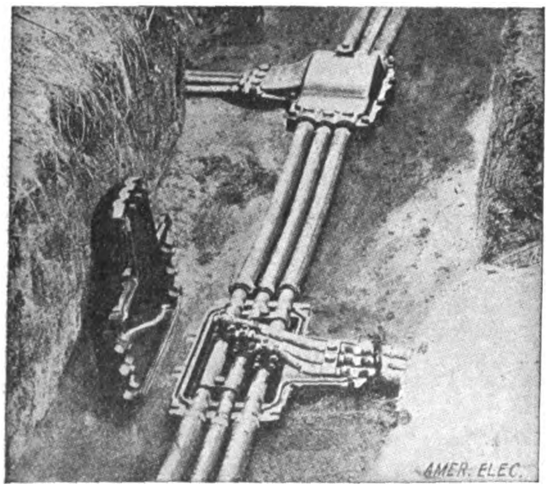


FIG. 1.—ELECTRIC LIGHT MAINS IN BUDAPEST.

Fig. 1 gives a good idea of the general practice here in Europe, and shows part of the electric light mains (three wire system) existing in Budapest. The cables are laid in a ditch dug under the sidewalk, which has a depth of 2½ to 3 ft., and is from 3 to 5 ft. from the house front. They are then covered with a layer of sand, on the top of which bricks are placed, which not only guard the cables against picks, but serve also as a warning to the excavator; and every laborer knows in this country (Austria) that when he comes or strikes on bricks that a cable is near by, and then takes extra precaution in working further.

The cables of the Budapest A. E. G. were made by Felton & Guilleaume, who have a factory there, and consists in this special case of a core of stranded copper insulated by their special composition, over which two lead sheathings are pressed; over these there is a layer of jute that is well impregnated with a sort of asphalt composition, and on this two iron bands are wound that serve as armor, while over the armor another layer of impregnated jute is placed.

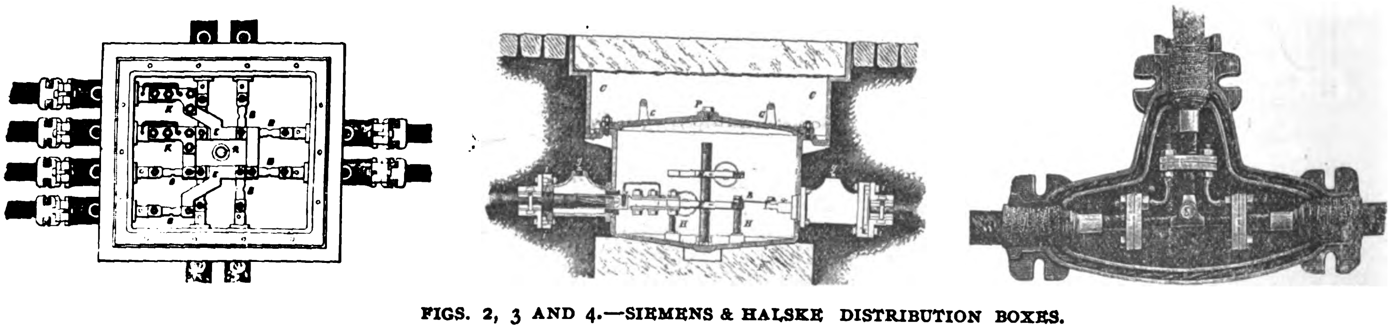
When considering the mechanical strength that such a cable possesses, and its high insulating qualities, together with the simple mode in which it is laid underground, there can be no doubt but that it will stand a lot of strain and hard usage, and that it is entirely self-protective; while on the other hand it gives us one of the best and cheapest methods of underground distribution.

Fig. 1 also gives us a view of two junction boxes, one opened and the other sealed, and it will be seen that they resemble those of the Edison system brought out in 1881. Another advantage in using cable is that it forms one long complete circuit, and does not necessitate a joint or connection every 16 ft. as in the old Edison system.

The distribution boxes at Budapest are generally placed on a solid brick foundation. Each of these boxes contains three insulated rings of copper which correspond to the three poles of the three wire system, and contains as many fuses as there are cables that enter it. The box is closed by a cover that is air and water tight, while access to it can be had by simply lifting an iron lid which is on a level with the footpath and forms a sort of manhole.

Siemens & Halske were among the first to construct lead and armored covered cables for electric light purposes, and their cables are in extensive use everywhere, and they, too, adopt the system of laying cables in trenches excavated under the sidewalk.

The Siemens & Halske system of underground distribution bears much evidence of careful design and study, particularly in matters relating to details. Figs. 1 and 2 represent one of their distribution boxes in plan and cross-section. Here the armored cables, which are simply buried in the ground, enter the box firmly clasped by means of small stuffing boxes that are bolted on to the main box, as seen. By means of the screw plug, g, insulating compound is poured into these boxes. It may be mentioned that this compound consists of waterfreed Swedish pine tar not containing any creosote, mixed with a heavy oil. Coal tar has not been found satisfactory for insulating purposes. The main box, which is shown in plan and cross section, is covered by an air and water tight lid (rubber packing being used). G represents handles, E E bus bars, K copper connections, B fuses, F



FIGS. 2, 3 AND 4.—SIEMENS & HALSKE DISTRIBUTION BOXES.

foundation, H H supports for the bus bars, while C is the pit covered by a flagstone. Joints and service connections are made as represented in Fig. 2, showing a concentric cable.

That armored cables are a success will be seen from the following table, which is a list of the cities that use the Siemens & Halske type:

Halske, told the writer that his firm considers the average life of their armored cable as 30 years, and that it reckons in all its estimates 1.94 per cent. of its cost as the yearly amount to be put aside in the redemption fund. Siemens & Halske have electric light cables that have been in the earth over 13 years, and they still show no signs of deterioration.

CITIES USING SIEMENS & HALSKE UNDERGROUND CABLES.

Name of City.	Total Length of all Cables Laid, Metres.	System Used.	Voltage.
BERLIN.			
Markgrafen-Strasse	156,500	Direct Current	120 to 140 volts
Mauer-Strasse	207,500	"	" "
Schiffbauerdamm	132,500	"	140 "
Spandauer Strasse	218,500	"	2 x 110 "
Tiergartenviertel	90,000	"	" "
VIENNA.			
Neubad Station	231,500	"	4 x 110 "
Mariahilf Station	112,000	"	2 x 110 "
Elberfeld	24,000	"	2 x 112 "
Mülhausen, i. E	16,000	"	2 x 110 "
Darmstadt	620,000	"	2 x 110 "
Salzburg	6,125	"	120 "
Hags	22,000	"	2 x 110 "
Stettin	42,500	"	2 x 110 "
Trient	90,000	"	4 x 110 "
Breslau	65,000	"	2 x 110 "
Kopenhagen	105,500	"	2 x 110 "
Stockholm	72,000	"	2 x 110 "
Helsingborg	14,000	"	2 x 110 "
Malaga	7,000	"	2 x 110 "
Sundsvall	31,000	"	2 x 110 "
Lyon	20,750	"	
Clichy, Paris	110,000	"	Five Wire System.
Toulon	2,400	"	Two "
Montpellier	400	"	Two "
La Coruna	2,700	"	Two "
Geneva	39,990	"	4,000 volts.
"	6,740	Alternating	2 x 110 "
Alicante	6,000	Continuous	3 x 1,500 "
Heilbronn	17,000	Alternating	3 x 100 "
"	9,700	"	
Cassel	6 500	"	2,000 "
"	57,600	Continuous	
Bremen	208,350	"	2 x 110 "
Graz	30,900	"	2 x 150 "
Chemnitz	9,800	Alternating	3 x 2,000 "
"	15,500	"	3 x 120 "
Rotterdam	15,000	Continuous	4 x 110 "
Valparaiso	15,900	"	2 x 110 "
Capetown	30,000	"	4 x 110 "
Leipzig	90,000	Alternating and Continuous	
Madrid	125,500	Continuous	2 x 110 "

Fig. 5 will give a good idea how armored cable is laid in a ditch, and represents the laying of the high tension mains in Cassel, Germany. Mr. Hanns Scheinig, an engineer connected with Siemens &

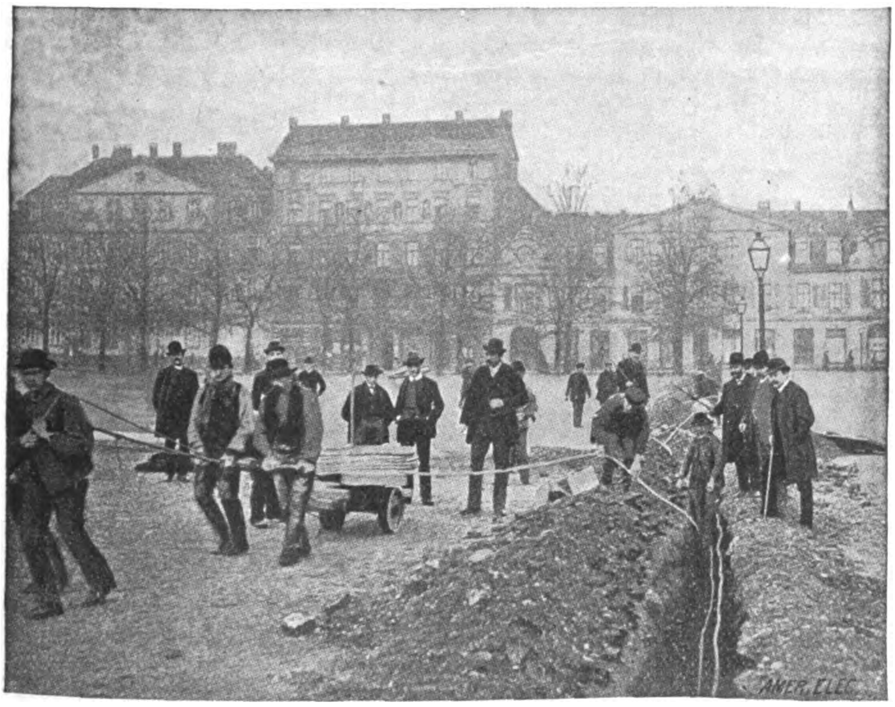


FIG. 5.—LAYING UNDERGROUND CABLE AT CASSEL.

Here in Brünn, where the writer is at present residing, there is in course of erection a three-phase station that will work at a pressure of 2,000 volts, and the underground mains are at present being laid. The cables are of the stranded conductor, three-core type, and are provided with two layers of lead and armor to make them self-protective. This type of cable is now a standard type, and made largely by Felton & Guilleaume.

The cable manufacturers, it may be mentioned, also undertake to lay the cables they deliver, and sublet the work of excavation to a contractor, who in this case (Brünn) has a gang of about 150 men, and with them lays and finishes about 4,000 feet (ditch length) of cable per day. The process of tearing up the sidewalk, digging the trench, laying the cable and then putting the street in order again takes but a few hours. Truly this method of underground distribution may be called a flexible-inflexible system. Armored cable can be laid or taken up quicker than by drawing in or taking out a cable or main from a conduit or subway.

The cable arrives from the cable factory wound on a large wooden drum, having a diameter of about 6 ft., the drum being strengthened by means of iron bolts, while its center contains a heavy hollow shaft. This drum as it comes from the railroad station is raised by means of a hoist attached to an iron tripod, and put on a low, heavy truck in a horizontal position. The truck is then taken and pulled by a gang of men to the distant end of the ditch, and here the cable is unwound from the drum and carried by the men (often as much as 60 to 70 men in a line) to the point of commencement, or to the end of the cable already laid.

Washed sand or sieved earth is then thrown on the cable to a depth of 3 to 4 ins., and on the top of this common bricks are laid, as shown in Fig. 6, where, a, represents the sand and, b, the brick. When the cable is laid in a street where there is a heavy traffic it is usual to lay also bricks *b*, *b* at the sides, as shown in the central view of Fig. 6. This precaution is also taken at all crossings, etc.

The Government or State here in Austria requires all cables that are laid in State roads (as distinguished from municipal or county roads) be provided or encased in a special conduit. In Brünn this extra protection is provided for at a few crossings, as shown in the cut to the right in Fig. 6, and consists simply of two U-shaped iron troughs bolted together, into which the cable just about fits, while two layers of bricks are sometimes used in this case instead of one. As there is generally only one or two Government roads running through a city, and as the cables are mostly laid under the footpath, there are only very short lengths to be taken in consideration where such extra precautions are necessary.

Fig. 7 gives a view in Brünn while laying polyphase cables. The wooden drum on which the cable is coiled, resting on the low, heavy trucks, is clearly seen in the foreground. The view represents a gang of men who are in a ditch and are hauling the cable across a roadway. The iron tripod to which the hoist is connected is also plainly seen in the background, and shows

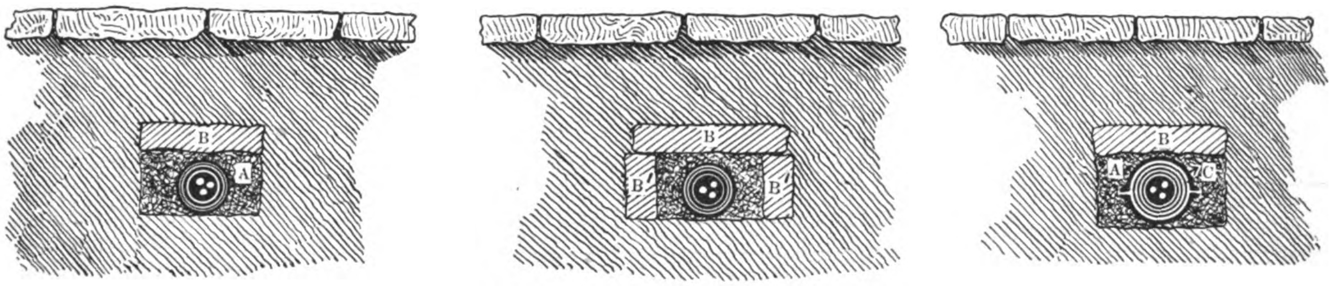


FIG. 6.—ARMORED CABLES IN THE GROUND.

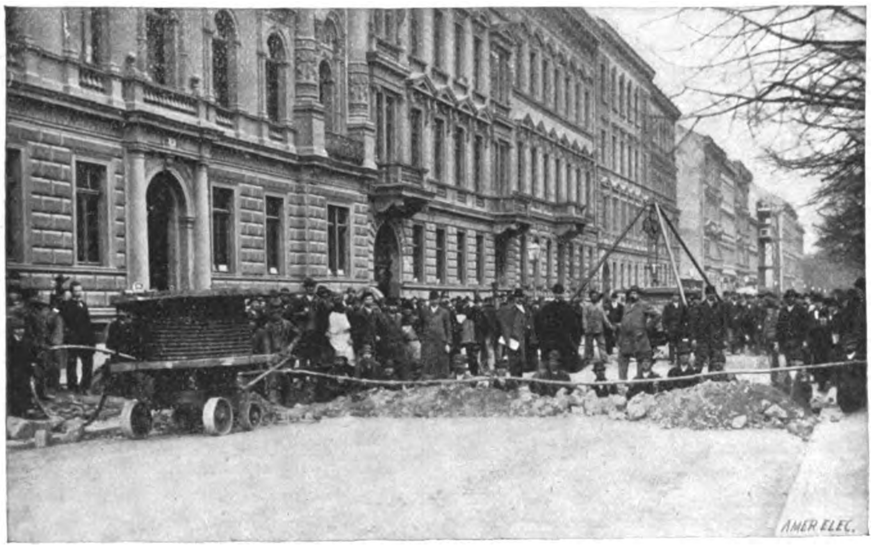


FIG. 7.—LAYING UNDERGROUND CABLE AT BRÜNN.

how the drum is hoisted on to the cable trucks. It may be mentioned that a heavy pin (the eye of which is seen in the picture) is inserted into the hollow iron shaft of the drum and keyed at the bottom; the hook of the hoist is then locked into the eye and the drum raised from the wagon that brought it from the railroad station and lifted, or rather placed, on the cable truck. The body of the cable truck revolves on ball bearings and with it, of course, the drum. Near the first lamppost in Fig. 7 will be seen two small smokestacks belonging to stoves that are placed on a small wagon, and serve to melt, or rather to heat up, the insulating compound that is used to fill up the junction boxes.

In Fig. 8 we have another view of the men hauling a cable in a ditch, and it may be well to notice the sieve and small mounds of sieved earth or sand that provides a comfortable bed and casing for the cable. Armored cable is never laid in such a straight line as pipes, conduits or ducts, etc., and this can be clearly seen from Fig. 5. Mr. Guiseppe Pagliari, who is the contractor laying the cables here in Brünn, remarked to the writer the other day: "See what a difference there is between the laying of light cables and gas pipes; here in Brünn I will lay about 23 miles of cable in about as many days, while if I had that length of gas pipes to lay with the same number of men I have now it would take over a year. Then again, with cable we can dodge obstructions; for instance, here we have just circled the manhole of a sewer which would have caused us lots of trouble if we had had pipes."

The International Company in Vienna, which uses high pressure, first laid its armored cables in simple wooden boxes, or troughs, lined with a coating of asphalt. The writer has, however, been informed that such boxes offer no protection, and decay in the course of four or five years and fall in. In Cologne the high pressure armored cables were laid in a wooden box suspended at intervals of about one meter by a sort of iron strap, after which the box was filled with a sort of asphalt compound, thus completely surrounding the cable.

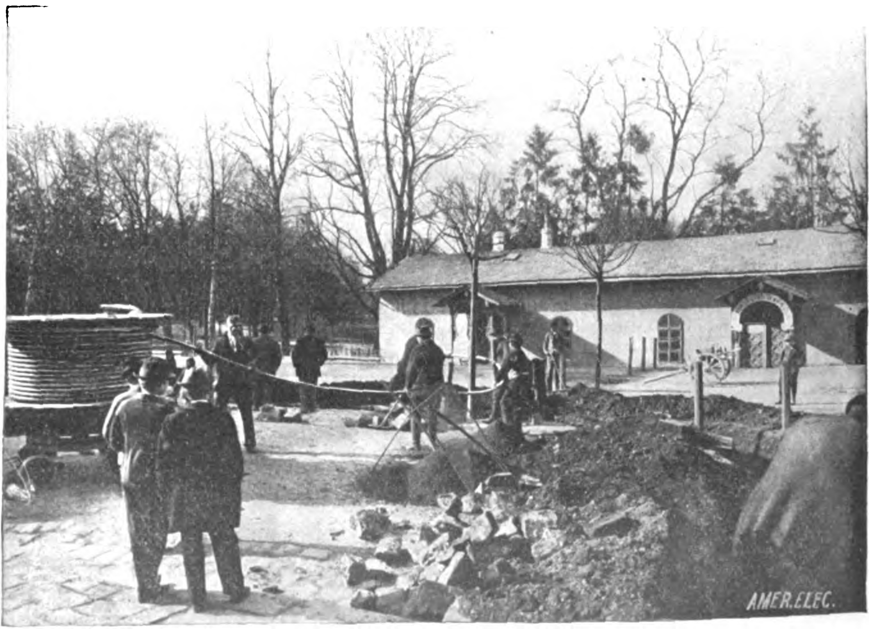


FIG. 8.—LAYING UNDERGROUND CABLE AT BRÜNN.

Fig. 9 gives a cross sectional view of this system, and it may be mentioned that the cable is of the concentric type, well armored. A German engineer told the writer lately that the above methods have been discarded, as the wood decays soon, and that the armored cables are now simply laid in the earth. The same may be said of other electric light companies in Germany and Austria, which also formerly built some kinds of concrete conduits and culverts, which, however, were found unnecessary to use with the high standard of armored cables manufactured to-day.

Fig. 11 represents a conduit that is used in connection with the Chevres-Geneva station. The conductors (bare copper) are laid in a concrete conduit that has a depth of about 12 ins. and a width of about 16 ins., while the flooring is about 30 ins. below the level of the soil. In this conduit the inside is first coated with an insulating compound of tar, after which the copper mains are stretched over porcelain insulators placed at a distance of about 2 feet from each other. The conduit is then fillled with an insulation compound of asphalt, which is poured in hot. Pilot and telephone wires are also laid in the conduit, as shown in the illustration.

In Fig. 10 is given a cross-sectional view of the conduit used in some parts of Zurich, and which consists of a stoneware trough placed beneath the footpath. The outer dimensions of the trough are about 7 by 7 ins. It is made in lengths of about 3 ft., which are connected together by cement joints. The protection of the conductors at Zurich consists of two lead coverings, and the cables are of the concentric type. After the cables are laid in the troughs they are covered with sand and further protected by means of a stoneware cover, which seals the conduit.

In Paris many of the cables are laid in the large sewers, while the Cie. Continentale Edison also employs a concrete conduit, as shown in Fig. 13. The cables laid in the conduit are generally of stranded copper, and supported upon porcelain insulators, as shown, which are held or carried by means of iron pins secured in the concrete. Armored cable is also largely used in France.

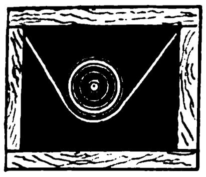


FIG. 9.—COLOGNE UNDERGROUND SYSTEM.

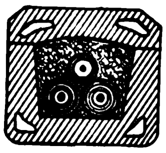


FIG. 10 —ZURICH UNDERGROUND SYSTEM.

In England opinion seems divided on the question of underground distribution, but there are many electric light stations that have armored cable simply buried in the ground. In fact, as may be seen from the data below, probably the majority of stations employ such a system. There are, however, many stations that have or use iron pipe, stoneware or earthenware casing or ducts. The following data were compiled by the writer from a statistical sheet published by the London Electrician:

Twenty-seven stations have armored cable simply buried in the ground and 46 have armored cable, but with no statement as to how it is laid; 28 have insulated mains in earthenware casing, pipes or conduits, and 22 bare copper in culverts, etc., the type not being stated; 48 have insulated mains in iron pipe, 7 insulated mains in iron troughs on the solid system, 6 insulated mains in iron troughs or conduits, and 13 insulated mains in bitumen casing or conduits.

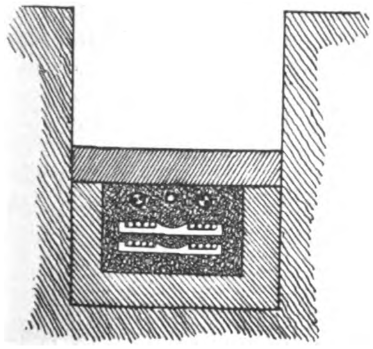
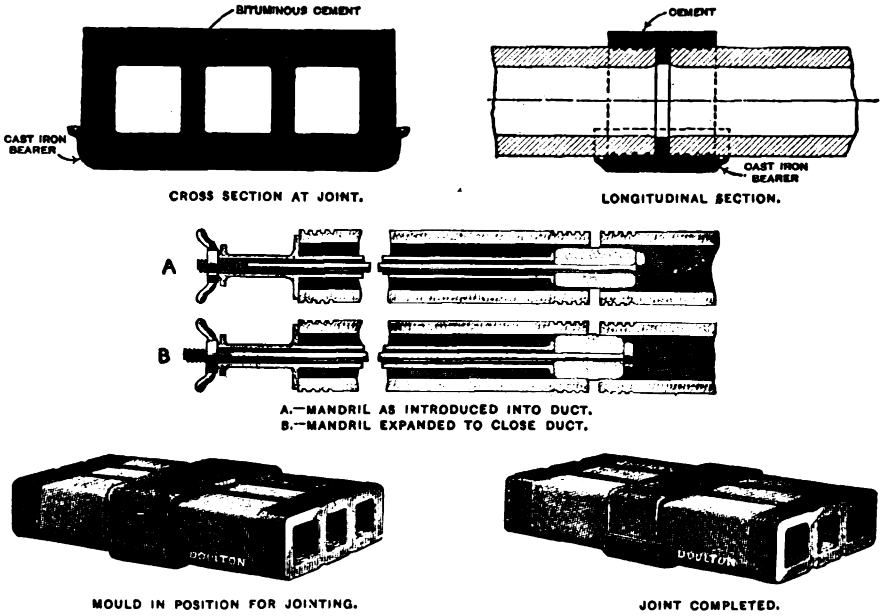


FIG. 11.—CHEVRES-GENEVA UNDERGROUND SYSTEM.

From the above it is seen that many English stations employ a mixed system, as some of the mains are simply buried in the ground, while others run through iron pipes or stoneware conduits, some stations having two or more kinds of underground distributions. It seems probable, however, that the item referring to armored cable should be classed with that relating to armored cables laid in the ground, in which case we obtain 73 examples, as it is not probable that armored cable is still further protected by laying it in pipes or conduits. The same is the case with insulated mains in stone conduits, etc., and bare copper in culverts; no doubt both these items belong under one heading as far as earthenware or stone conduits, culverts, etc., are concerned.

We thus see that in England armored cable also takes the lead, while the stoneware and iron pipe systems are about equally divided as far as systems go, and it would be interesting to obtain data regarding the relative lengths of these various methods.



CROSS SECTION AT JOINT.

LONGITUDINAL SECTION.

A.—MANDRIL AS INTRODUCED INTO DUCT.
B.—MANDRIL EXPANDED TO CLOSE DUCT.

MOULD IN POSITION FOR JOINTING.

JOINT COMPLETED.

FIG. 12.—DOULTON CONDUITS.

The advocates of armored cable all claim it affords the greatest security against gas explosions, electrolytic action (which sometimes takes place in conduit systems where bare copper is laid); nor is an armored cable liable to act as a drain pipe or be subjected to overflooding as in the case of a conduit system. However, it is just to assume that many of the so-called drawbacks of the conduit systems are more of a theoretical nature than anything else.

One thing which the armored cable men claim with justice is the ease with which they can lay the mains, as they can dodge all underground obstructions; while in building conduits or culverts in ground that is full of gas and water pipes, pavements undermined by coal cellars and the like, necessitates much work and expense.

Of the various earthenware conduit systems used in England, the Doulton type takes the lead, and much time and money have been expended in making this system a standard one. Over 40 electric light stations use the Doulton conduits, which speaks for itself, and there is no denying that this admirable system presents many favorable features. For feeders the advantage of the drawing-in system is a real one, as cables can be withdrawn and replaced by larger ones when necessary.

These conduits are manufactured of hard-burnt and glazed stoneware, and possess great strength and toughness; they are an insulator in themselves, are unaffected by heat, are proof against chemical action and gases found in the ground, and may be regarded as imperishable. As the interior surface of the ducts is smooth and hard, they present exceptional facilities for drawing in cables without any risks to the insulation. The ducts are generally laid under the footways at the bottom of a trench 12 to 18 ins. from the level, and in roadways subject to heavy traffic a depth of 3 ft. is usually adopted.

They are also laid near the surface on a bed of concrete, and this method is frequently used where the conduits are carried from pavement to pavement across roadways. The lengths are laid with a small space between them on shallow cast iron bearers, as shown in Fig. 12. A mandril with India rubber head is then introduced into each of the ducts, as shown, and when opposite the joint it is expanded by a few turns of the thumb nut at its end. A removable iron mould, open at the top, is placed over the joint, and then filled with a special rapidly setting bituminous cement, which hardens in two or

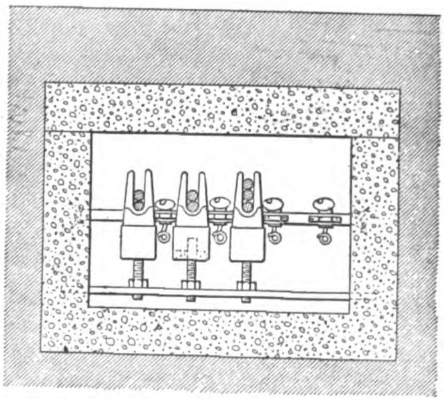


FIG. 13.—PARIS UNDERGROUND SYSTEM.

three minutes, when the mandrels are unscrewed and withdrawn and iron cover removed.

For house service connections a special split-length is used. Fig. 14 represents a system of house service boxes designed by Prof. A. B. W. Kennedy, and of which over 2,000 have been used at Edinburgh. The box consists of a short length of casing, the body of which is partly divided longitudinally in such a wav that the upper and lower portion may be easily separated by means of a chisel when required. The box is laid in the same way as the ordinary casing, or it may be subsequently introduced into the line of conduit, in which case it is substituted for an ordinary length, which may be removed at any required point. When it is desired to make a house connection both halves are removed from the line of conduit, and thus ample access to the cables is afforded.

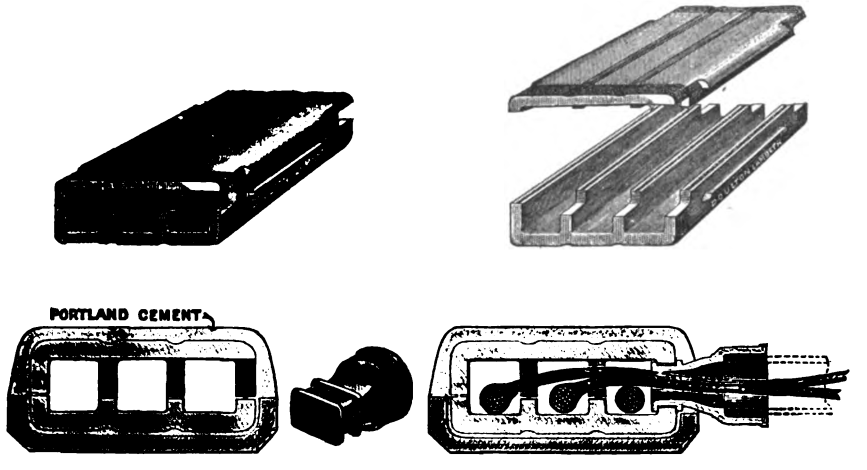


FIG. 14.—EDINBURGH SYSTEM.

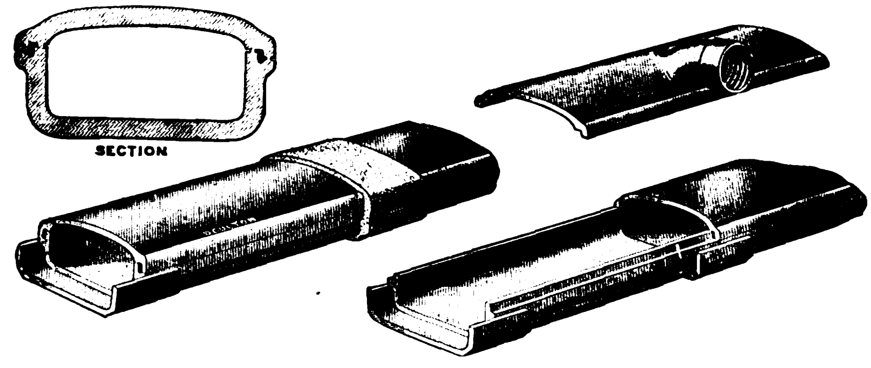


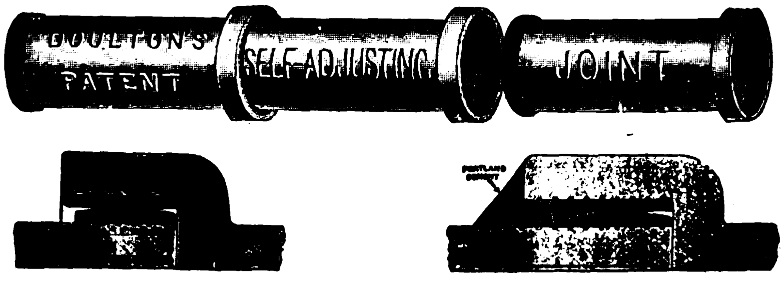
FIG. 15.—DOULTON SYSTEM.

The cable connections having been made, the box is replaced, and in making the joints with the adjacent lengths of casings a special cast iron collar is used, provided with an outlet through which the branch cables are conveyed. When the casings are jointed with Portland cement the same type of box can be used, the slots at the end being enclosed within a cement joint, as shown in Fig. 14. When a house connection is required the upper and lower portions of the box are readily divided, and the cast iron connection socket shown inserted in the outer slot. The socket takes an iron pipe which leads into the consumer's premises. Another illustration of the Doulton conduit system is shown in Fig. 15, which explains itself. The ends of the lengths are laid on stone chairs and jointed with Portland cement, as already described. The conduit is supplied with cover attached, which can at any time be detached by means of a chisel and replaced by a special cover provided with socket for branch cables, as shown above.

Several cities in England have also the Doulton glazed stoneware pipes with self-fitting joints, as shown in Fig. 13, for underground distribution. The joint in the Doulton pipes is a sort of artificial "bored and turned" joint, formed by casting on the spigots and in the sockets of the pipes rings of a durable material, which, when put together, form a mechanical fit without the use of cement. The pipes can be laid very rapidly and the ground filled in at once. Many miles of these pipes are to be found in Manchester, Stafford, Oswestry, Leeds, Preston, etc. It may be mentioned that the joints admit of deflection without leakage. Glazed stoneware pipes are obtainable at a fraction of the cost of iron pipes. The lower part of Fig. 16 gives a section of an ordinary joint and also a section of a composite joint, the latter having an addition of an exterior fillet of Portland cement.

Of the various subway systems in use in England none surpass the Doulton type. This type has been adopted in many of the principal cities of England, and finds favor, as they are much cheaper than iron subway, their cost being about the same as concrete ones, while, on the other hand, they are made of an insulating material (glazed stoneware), and can be quickly laid. The subway is made in two feet sections, the ends of which rest on stone cradles, and are jointed by cement, as shown in Fig. 17. During the process of manufacture a recess is cut out of every third section, into which an insulator is set in pitch, as seen in the Fig. 17. The copper strips are then laid into the slots of the insulators and the subway covered with flags or slabs with rabbitted joints. The subway is placed under the footpath, and in some cities insulated cables in iron pipes are used when crossing a roadway.

Messrs. Laurence, Scott & Co. have also designed a very neat form of subway that is laid in Norwich and elsewhere in England, and which is claimed to be much cheaper than the concrete system. This system is shown in Fig. 18, and consists of highly vitrified porcelain insulators cemented in nicks cut into the socket end of an ordinary drain pipe, as shown at right. As will be seen, the projecting ends of the insulators form but a small contact surface with the pipe, and there is plenty of space for water to drain and for the copper to sag. For a 9-in. pipe there are five ducts, each of which will carry 1 sq. in. of copper, three being used for distribution and two for feeders. The pipes are bedded in and covered with cement for about 3 ins. to protect them against damage. The copper is not drawn until the conduit is finished, while only copper for existing requirements is put in place, as more can be added at any time by pulling out the top strip with a draw-in cable attached, and then pulling it back with the additional copper required.



SELF-ADJUSTING JOINT COMPOSITE JOINT

FIG. 16.—DOULTON JOINTS.

A manhole is placed at every change of direction and connected to the sewer by means of a special trap. The ventilation is effected by means of vertical pipes placed at the higher points and carried up the sides of neighboring buildings; or by ven-

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tilation cowls close to the nearest wall. The cost of a 6-in. subway laid complete under macadam roads, with 3 ins. of cement concrete all round, including manholes, 1½-in. pipe for pilot wires, is about $2.25 per yard, while the corresponding cost for the 9-in. culvert is about $2.88 per yard. The cost of drawing in copper averages 2 cents per pound.

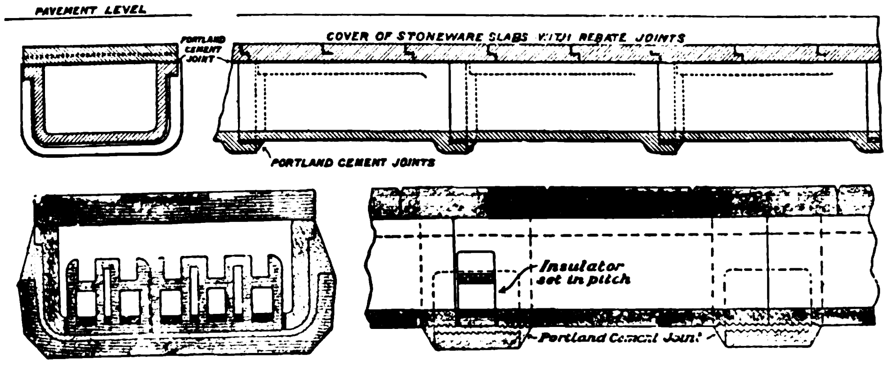


FIG. 17.—DOULTON SUBWAY.

The cost of a Scott 9-in. subway with the five ducts half filled with copper, 2¼ sq. in. section in all (copper at 16 cents per pound), is about $4.80 per yard. The cost of the subway complete, of drawing this copper in, and of connecting up, will come to $3.48, making a total of $8.22 per yard.*

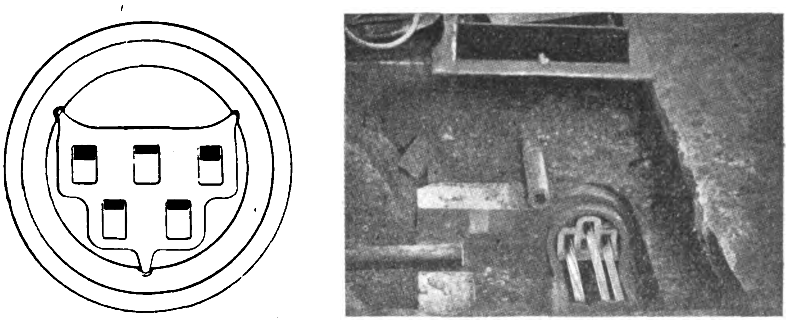
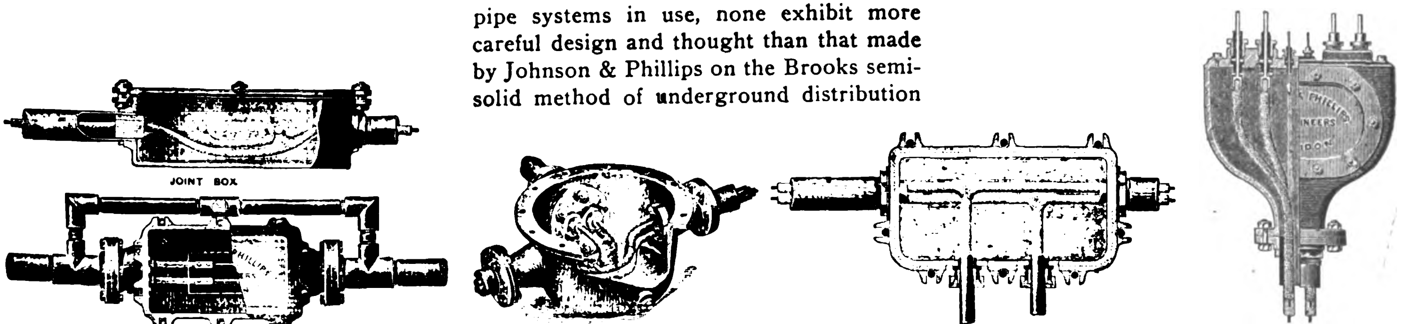


FIG. 18.—SCOTT SUBWAY.

Several cities in England use the Crompton conduit, which is made (in situ) of concrete and resembles the system shown in Fig. 13. In this system bare conductors are tightly stretched between porcelain insulators carried by cast iron bearers. The conduit is usually laid, or rather built, under the sidewalk, while at intervals of about 16 to 18 yards a manhole cover is placed, in order to take out service wires, and at intervals of about 100 yards large manholes are constructed that afford room for the workmen when drawing in or out copper.

The Westminster Company, of London, uses a concrete conduit designed by Prof. Kennedy, as shown in Fig. 19, which, it will be seen, is similar to the Crompton system. The bare copper conductors are here supported on solid porcelain insulators placed directly in the concrete flooring of the conduit. The manholes, etc., are placed at intervals as in the other systems already described.



JOINT BOX

DRAW-IN AND TEST BOX.—CHATHAM TYPE.

JUNCTION BOX.

SERVICE BOX—ROCHESTER TYPE

TERMINAL BOX.

FIG. 20.—DETAILS OF BROOKS CONDUIT SYSTEM.

Many companies employ cables which are well insulated and possess lead coverings but not armor, and are simply drawn in cast or wrought-iron pipes laid under the pavement. At street corners, and at intervals of 80 to 100 yards, cast-iron surface boxes are inserted with the usual adjustable lids. Of the various iron pipe systems in use, none exhibit more careful design and thought than that made by Johnson & Phillips on the Brooks semi-solid method of underground distribution

In this system the copper conductors are covered with two helical bindings of fibrous material, impregnated with an insulating compound. The conductors are then drawn into iron pipes, which are afterwards filled with a semi-solid dielectric possessing high insulation qualities. This system comes under the class that is technically known as a draw-in and draw-out type, and appears to fulfill all the conditions that are required in high-tension circuits. Kapp, it may be mentioned, tested a line or main built on the Brooks system with 10,000 volts, and found that the line behaved much better than the testing transformer. This system is laid in Brighton, Chatham, Glasgow, Keswick, Rochester and Worcester, Great Britain, and in a large number of private estates.

The iron tubes, which have a length of about 15 or 16 ft. and are bell-mouthed at each end, merely require connecting together by means of the ordinary screw socket. As each successive length is added it is threaded over an iron wire, this wire being afterwards used for drawing in the steel rope for hauling in the cable. Every other length of tube is connected together by means of a T coupling closed at the top with an ordinary plug, the opening being required for filling in the semi-solid dielectric which, when heated to 300 deg. F., is quite liquid. When the line takes a bend, it is usual to use enlarging sockets and put in a tube one size larger than the normal. The tubes are connected up to cast-iron draw-in junction or terminal boxes when required. Fig. 20 shows a terminal box, junction box, joint box, draw-in and test box, and a service box.

The cable is hauled through the pipes by means of a winch, and roller guides are arranged where the cable comes out of a tube or box, so that the fibrous covering may not be injured by undue friction. After the cables have been pulled in and the joints made, the insulating dielectric is heated in cauldrons to about 400 deg. F. and poured into the tubes at the various points. It is of great importance that the whole of the air should be expelled and the tubes be perfectly free from moisture.

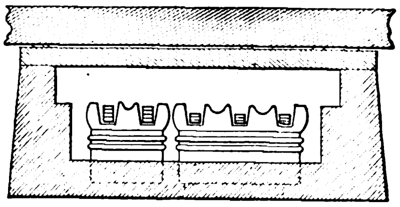


FIG. 19.—KENNEDY SUBWAY.

There can be no doubt that such a system has a long life, and the writer, who has had some experience with the Edison system (the type that was made in 1881), found that the iron pipe withstood the corrosive action of the organic acids that are sometimes found in the earth for over a period of 15 years. In Brünn he had a line about 1,300 ft. long, and after 13 years found that a portion under a crossing where there was always a heavy traffic, and consequently also a place where much animal refuse existed, tending to the formation in the earth of ammoniacal gases and saltpetre, the iron pipes were damaged and at some parts completely eaten away. The greater length of the line ran through a park and in clean earth, and here the tubes were still in good condition, showing no traces of deterioration.

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*Taking the price of labor and conditions in England.

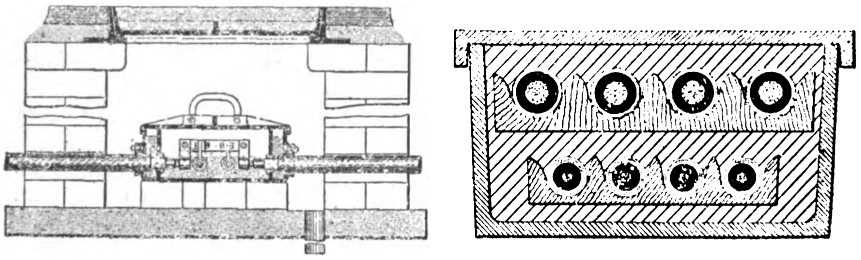


FIG. 21.—CALLENDER TROUGH SYSTEM.

It will be remembered that the iron pipes of the first type of Edison mains were not thick, and that later on stronger tubing was employed. The latter tubes will stand the damaging action in some kinds of earth much longer than those in the case cited above. The writer found that iron pipes wound or covered with a good layer of coarse jute cloth that is well impregnated with a thick paste of asphalt boiled in linseed oil, lengthened or increased their life about 5 or 6 years. The asphalt covering protects the iron against acids of the earth and lasts about the time stated before the iron is exposed at all to their action.

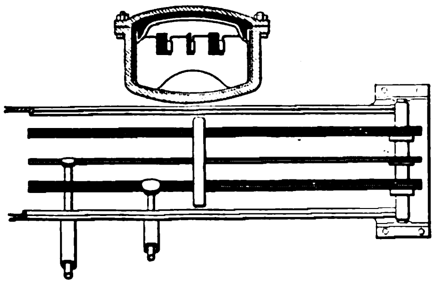


FIG. 22.—ST. JAMES AND PALL MALL COMPANY'S CONDUITS.

Other iron pipe systems are similar in many respects to the one described above, minus the filling-in part with heavy oil. It must be admitted that all such systems are to some degree complicated on account of the joints, etc., and the skilled workmanship required in the streets, where it is more expensive than in a factory.

Of the iron trough systems none is better known than the Callender solid system as shown in Fig. 21. In this system the insulated cables are supported by wooden bridges held firmly in a cast iron trough filled with Trinidad bitumen and covered by a cast iron lid. This system has given excellent results and seems to be able to exclude moisture well, while at the same time providing ample protection for the cables.

The troughs are in lengths of 6 ft. and laid under the pavement. The junction boxes and manholes all show careful design, but the system seems, on the whole, a very expensive one to employ. The Callender system is also employed at some places where the troughs are made from wood instead of cast iron. Iron troughs, it may be mentioned, are quickly and cheaply laid, but are objectionable on account of their high first cost and the possibility of short-circuiting or the occurrence of electrolytic action.

The St. James & Pall Mall Electric Light Company, of London, have some of their mains laid in iron troughs, a view of which is given in Fig. 22. The bare copper conductors are supported in this system by means of porcelain bridges held firmly in position and placed at intervals of a few feet. The troughs are covered by means of a well-fitting water-tight iron lid, which is secured by means of bolts and packing. Special precaution is taken concerning drainage, as water is apt to get in.

Another iron conduit system is the Johnstone, but of which little is now heard. no doubt on account of its first cost and the preference which now seems to be given to the earthenware systems already described. The Johnstone system consists of troughs made in sections so that a conduit of any capacity can be built, as shown in Fig. 23. At frequent intervals service boxes are placed, while at corners expensive manholes are built of iron. This system, like other iron trough methods, is open to the same objections as have been stated above.

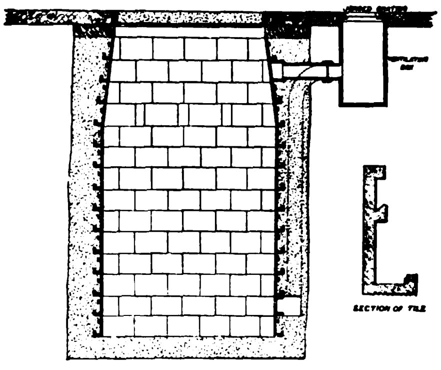


FIG. 23.—DOULTON TRANSFORMER SUB-STATION.

A few concerns have what is known as bitumen conduits or casings, which are generally made from bitumen or pitch concrete, moulded around mandrels and formed into tubular blocks. The ducts are jointed with a hot mixture of bitumen, and are exceedingly difficult to lay as regards alignment.

Having described the various systems of underground distribution used in Europe, it might be well to end with a few words on transformer chambers and pits.

In connection with Continental underground distribution, it is the general practice to place transformers, etc., above ground, in a sort of kiosk constructed of iron, and very similar to the newspaper kiosks seen on the Boulevards in Paris, which are accessible and permit easy inspection. Fig. 23 gives a picture of a kiosk of a kind used in Chemnitz, Germany, and made by Siemens & Halske. They are to be found in nearly all German cities and are about 13 ft. high and about 4 ft. in diameter. They rest on a solid brick or concrete foundation and consists of two chambers, the upper one of which contains the transformer and has three doors that permit easy access and inspection from all sides; the lower chamber contains the switches, fuses and cable ends and has one door.

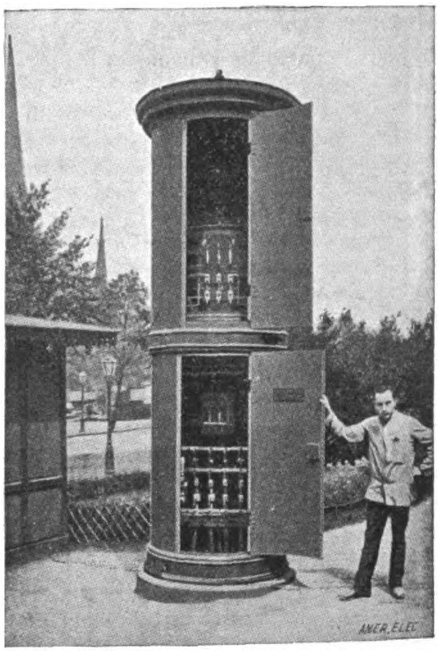


FIG. 24.—TRANSFORMER KIOSK.

These kiosks are self-ventilating, having a sort of open, bell-shaped roof that allows ample circulation of air, and yet so constructed that rain or snow cannot enter. This type of transformer sub-stations has proven very satisfactory, as they are not expensive, their maintenance costs hardly anything, and their form or appearance permit of any decoration that may be required to put them in harmony with their surroundings. It may be mentioned that such overground chambers are never troubled with water condensing inside, as in the case of underground chambers.

It is a common practice in England to build underground pits or chambers by erecting two walls, with a space between space filled with hydraulic cement or pitch. In some cases concrete pits are built lined with asphalt. Of late the Doulton system has been finding favor everywhere, and is generally adopted as a standard. Fig. 24 gives a sectional view of the Cockrill-Doulton pit, which is made of concrete and glazed tiles. By the use of such tiles, concrete walls are constructed without the aid of any wood or iron framing. The operation of building is performed by laying a course of tiles to form the face of the wall, and filling the space behind with soft concrete, the weight of which on the horizontal flange keeps the tile in a vertical position. This operation is repeated course by course. A glazed surface is obtained with fine joints in cement, so that on the whole it makes an ideal underground structure.

Walls built on this system are said to be monolithic, waterproof and durable. The ventilation is provided for, as shown in Fig. 24, by means of a box with hinged grating; it can also be provided by means of pipes ending in a grating standing against a wall about 10 ins. above the ground.

In conclusion, the writer desires to thank Messrs. Scheinig, Krugl, Goetz and Pagliari for the courtesy shown him in the preparation of this article.

ELECTRIC POWER ON WAR SHIPS.

ELECTRICAL POWER TRANSMISSION ON SHIPBOARD.

BY F. W. ROLLER.

The modern man-of-war, about which this article is mainly concerned, is, as is well known to the readers of this paper, a huge hulk of steel, dependent entirely for its propulsion, handling and fighting, on power generated within itself; the same being, almost without exception, coal burned in boiler furnaces.

Of course, the steam thus generated that is to be used for the propulsion of the vessel is best utilized by the main engines, usually two in number, which, owing to their size and steady load may be, and are, so designed by the use of multiple cylinders, high speed, high boiler pressure and other well known devices of modern practice, that a maximum of economy is secured.

The wisdom of this practice in view of the present state of the art cannot be questioned, but the operation of the various auxiliary mechanisms by steam-driven prime movers is another mattter.

To one not familiar with the facts of the case, the number and total power required by these auxiliaries is apt to be a surprise when first learned of.

Beside the usual feed, circulating and air pumps that would naturally go with a high pressure condensing installation, and the bilge, fire and flushing pumps, we have large ventilating fans, steering engines, capstans, hoists (both ammunition and for other work), apparatus for moving turrets, heavy guns, etc., etc., all of which are steam driven. These small engines are widely scattered throughout the ship, and in most cases require careful attention to keep them in order.

The question of conducting the steam to these and the exhaust away again is a serious matter. The steam pipes of all engines which might be used in action must be carefully protected in the best possible manner, not only because of their being so readily disabled by a shot and because of the difficulty of making any temporary or permanent repairs on such a pipe without great loss of time, but more particularly because the escaping steam would probably cause greater mortality in its compartment than the shot or shell which caused the break. The protection required is in a large measure gained by the course adopted of making the runs as far as possible below the protected deck. This, on the other hand, leaves them as a rule inaccessible, and further heats up spaces that are already far above living temperatures.

The inefficiency of these small engines is also great. In a man-of-war the points to be striven for are offensive power, defensive power, speed, and a large steaming radius. These are all inter-dependent and if, of a given supply of fuel, we are wasting a certain proportion in uneconomical engines, we are losers, not only by the value of the fuel, but by the decreased efficiency of the whole vessel.

The able paper read before the American Society of Naval Engineers by P. A. Engineer W. W. White, U. S. N., giving an abstract of the exhaustive tests made by him on the steam consumption of the various engines of the U. S. S. "Minneapolis," will give some idea as to how wasteful some of the engines are. Of course, in the case of the pumps, which are taking steam for the full stroke and running at a very low speed, the steam consumption would naturally be expected to be high, but when 250, and in one case 300 lbs. of water per hour are exceeded, even if less than of one h.p. is being developed at the time, the matter becomes graver. Even in the larger engines, like those for running the blowers, ice machine, dynamos, etc., where the average load is quite steady and the conditions favorable to fair economy, we find the water consumption running from 70 to nearly 110 lbs. per h.p.

Another point which prominently presents itself as against the use of small steam engines is the structural weakening of the vessel which they cause in many cases. Take the ventilating apparatus for instance. It is the usual practice to have two or three groups of large fans centrally located, and to lead the air to and from them through the various compartments by sheet metal air ducts often 4 to 6 square feet in cross section, which are carried through openings cut in the bulkheads for that purpose. Beside weakening them as above stated, this further introduces a large factor of uncertainty into the preservation of the other aim for which bulkheads are used—to obtain safety from sinking by the formation of water-tight compartments.

To be sure, automatic valves or shutters are used which are supposed to operate in case of flooding of the compartment, but there is some question as to their value. Where matters are such that it is still a matter of dispute between experts as to whether it would not be better to omit all openings whatever serving as a means of communication between compartments, sealing the present water-tight doors which are in plain sight, easily inspected and frequently tested, it becomes evident that such automatic valves in air ducts are still less worthy of confidence.

This difficulty could, however, be surmounted, provided that independent ventilating apparatus was employed for each compartment and the trunk air mains abandoned, but it has been decided that the increase in number of small engines thus necessitated would be the greater of the two evils.

From all the above, it will be seen that auxiliary steam engines have a minimum of good qualities, although even they have for most purposes marked advantages over hydraulic or pneumatic systems, both of which have been tested in small way.

An electrically driven installation would, on the other hand, seem to meet all of the objections raised. The units for the generation of the current would be amply large to give high economy with the use of the multiple-expansion high-speed condensing engines that would be employed, and they could all at the same time be located below the protective deck, like the main engines themselves, where they would be safe, and under constant observation by the expert engineer corps. It would be fair to assume from the results of data taken under modern practice that the efficiency of transmission from the cylinders of the dynamo engine to the point of application of the motor power would be such that the steam consumption per brake—not as in the case of the tests on auxiliaries cited, indicated h.p.—would average no more than 30 lbs., which is less than half of the best showing made by the steam engines, and less than one-tenth of the worst.

On the same test on the "Minneapolis'" engines that we are considering, the auxiliary engines were found to consume nearly 25 per cent. of all the steam generated or out of 5,200 lbs. of coal per hour, 1,300 lbs. were chargeable to them.

As the average steam consumption per h.p. hour of the auxiliaries was nearly 100 lbs., bringing this down to 30 lbs. by the use of electric transmission means a saving of 70 per cent of the fuel, or of the 1300 lbs.; 910 lbs., per hour, nearly 11 tons per day. It must be remembered that this is under cruising conditions where the load is comparatively light, and that the saving would be greater if the load were higher.

If electric motors are used, the objectionable heat and odor of corresponding steam engines for the work would, of course, be done away with, and the danger from burst or broken pipes also eliminated. We would further save largely in space, not only because of the much less bulk of the electric conductors, but because of their flexibility, which allows taking advantage of many breaks and recesses which a lagged steam pipe would have to jump over.

The motors themselves are also smaller and, more important, simpler, a single rotating piece being substituted for the numerous reciprocating parts, and they can be started, stopped, and, if required, reversed far more quickly.

In the use of electric transmission as above advocated, there is one arrangement which has never, we believe, as yet been used, which would seem to offer marked advantages and is as follows: In the first place, a number of the auxiliaries not only need never have their direction of motion reversed, but when in operation at all run at a constant speed. While the ordinary direct current motor would fill this condition admirably, the multiphase induction motor offers great advantages even over this, owing to its simplicity, unequalled among power generators, and its ability to withstand the roughest usage. In order to be able to utilize it, it is only necessary to add to the ordinary direct-current generator three or four collector rings acccording to the system selected, and take the current from there by stationary brushes in the well-known way and carry it to the motors. This would add only in the slightest degree to the complication in the engine rooom; certainly not enough to embarrass the trained engine room force, but will leave matters at the motor end, where unskilled men are often in attendance, in such absolutely simple shape that it would seem to be practically impossible to dearrange or disable the machinery.

Particular stress is laid on this point, as the writer has more than once seen even the simple direct current motors put out of commission in a few months' run, owing to improper brush setting and too rapid starting, both of which are impossssible with the induction motor.

In conclusion, the use of electric motors would not be experimental in any way, all of the apparatus that would be employed being standard material that is in everyday use all over the civilized world. Its advantages are manifest, and it is to be hoped that they will soon be recognized by the authorities and employed both for their own good and that of the profession.

THE MODERN STEAM ENGINE.

ECONOMICAL MANNER OF WORKING STEAM IN ELECTRIC POWER PLANTS.

BY PROF. WM S. ALDRICH.

Steam engines for electric power plants should be so designed and installed that they may be operated at any time under the most economical conditions consistent with the varied requirements of such electrical supply service. To-day the demand is heard on every hand for greater economy in operation, reduced cost of management and increased reliability of service. It is our present purpose to consider more particularly the increased economies to be obtained in the manner of working steam in the engine cylinders. This is the primary question. It is quite irrespective of the size of the plant or the character of the load. It is, therefore, necessary to understand the relative merits of the several possible methods of working steam in the modern power plant engines. Such an understanding will clear up many apparent difficulties. There will thus be established a rational guide, and the only safe one for central station managers and power plant engineers. Without it all else would be pure empiricism.

Central station men may have to decide between two almost equally good but rival methods of working steam; as, for instance, between compound and triple expansion engines, or between the use of jackets and reheating receivers in either case. Attention is again being directed toward the use of superheated steam, though the highest steam pressures have not yet been practically introduced, nor the corresponding available expansions all utilized. Nevertheless, the present day demand for greater economy in the use of steam must involve a recognition of the value of superheating.

There are questions of construction, of maintenance, and of subdivision of the steam motive-power into units requiring consideration, and which may serve to fix a reasonable limit to the pressure to be carried and the number of cylinders to be employed. Yet it is not a question of the number of cylinders alone, but of the number of expansions and of how many cylinders it is advisable to employ in order that the range of temperatures of the working steam shall not be too great in any one cylinder—that is, not more than 70° Fahr.

The question of the economic working of steam, on the other hand, is not altogether a question of high pressures, though this permits of two advances in the right direction—on the one hand a greater range of expansions, and on the other hand an increase of the temperature range within which the steam is to be used. The latter feature, however, may be realized by the use of superheated steam, but at the sacrifice of any economic gain by the increase of the number of expansions. Moreover, it will require a greater expenditure of fuel to superheat the working steam, say, corresponding to an additional 100° Fahr., than it would to raise its pressure to the temperature corresponding to this superheating. It is, therefore, quite probable that the American practice will continue to advance rather in the direction of higher steam pressures than of superheating, if it is only possible to provide for the increased strength required of all structural parts of the steam power plant.

If we look upon the steam engine as a heat engine, the conditions producing the highest efficiency of operation are high temperature of admission and low temperature of exhaust. No limit has yet been reached for the temperature of the admission of steam. But in no case is it possible, much less practicable, to push this utilization of the heat energy in the steam to its other extreme limit. That limit is early fixed by the temperature of the steam corresponding to its exhaust pressure and the highest attainable vacuum in condensing engines. While the high initial temperatures may be readily obtained by increasing the pressure of the steam or by superheating it at a lower pressure, it must be borne in mind that we are working with a condensible vapor in the first instance and a steam gas in the second instance highly sensitive to radiation losses. However, this is far from being the only dictum.

Experience has shown that the best economy is to be obtained only when there is no condensation of the steam due to the cylinder walls during its admission and expansion. That is, there must be no cylinder condensation throughout the stroke, and the cylinder walls must be dry at the point of release of the steam from the cylinder. These are entirely new conditions imposed upon the use of the steam in any case. All else about the steam engineering of the electric power plant may be as perfect as can be made by the refinement of modern engineering design, yet disastrous economical failure may await the operation of the plant from a mistaken notion of the unimportance of this question of moisture in the working steam. The additional heat in the superheated steam, therefore, gives us the second advantage in that the cylinder condensation may be quite fully counteracted, if not entirely obviated.

The two advantages of high pressure steam are an increase in the temperature range and a greater number of expansions. The two advantages of superheated steam are an increase in the temperature range and the counteracting of the cylinder condensation. We may combine these, it is true, by the use of superheated steam at a high pressure, and yet fail to obtain the highest efficiency and the best economy possible under practical conditions.

So far we have been examining the economic conditions imposed upon the use of steam only at the beginning of its cycle. Quite as important a relation has now been fully established respecting the condition of the steam at the point of its release from the cylinder—namely, the cylinder walls must be dry at the point of final release of the steam.

It is not to be expected that any reasonable amount of superheating of the initial steam will fully compensate for the cylinder condensation and other losses during its expansion to the point of release. There must be some external provision made for supplying the heat necessary to keep up the temperature of the cylinder walls and that of the working steam. This has been satisfactorily accomplished by steam jackets, either on the barrel of the cylinder or on its heads. Another method for supplying heat to the steam is that of the reheating receiver placed between the cylinders of compound engines.

If live boiler steam is used in the jackets as well as in the receivers, it will result in the expediture of a little heat, it is true, but in one of the most efficient ways yet discovered. The amount of heat is taken from the principal, but it results in a cumulative income. In no other way can a little extra fuel be expended to so great an economical advantage.

These guiding principles will be of equal service, whether applied to existing installations or projected power plants. Under any given condition, the criterion of economical working is that the cylinder wall should be dry at the point of release of the steam. The line of investigation is therefore backward rather than forward. What conditions will secure this in any given case?

In single cylinder engines, a little superheating of the admission steam combined with the use of steam jackets. In compound and triple expansion engines, a little superheating combined with the use of steam jackets and reheating receivers. In any case, if it is not possible to slightly superheat the admission steam, it must be delivered to the cylinder during admission as dry steam, and the cylinder walls must be kept sufficiently warm by a greater expenditure of heat in the live boiler steam and jackets. In the case of multi-expansion engines, however, it will be found especially advantageous to expend a large amount of heat from the live steam in the reheating receivers.

With reference to existing plants, for instance, an outlay for installing superheaters or economizers will be met with early and gratifying returns in the way of reduced coal bills. In fact, such an economic investment will be similar to that for non-conducting pipe covering; namely, it will probably pay for itself in the first year of use. Respecting reheaters, there is scarcely an existing plant that might not enjoy the advantages of these at slight outlay. If it is possible to raise the boiler pressure, securing higher temperature and greater range of expansions, it will even be found economical to take out existing high pressure cylinders and replace them by smaller but properly proportioned ones and install reheating receivers.

The conditions of electrical supply are so radically different in the isolated plant from those of the central station that it would really require a separate treatment. In the former the load is not so variable. The service is entirely local. It is largely made up of all-night electric lighting, combined with some day lighting, but more extensive motor and elevator service during that period. In the winter season the exhaust steam of the engines is required for steam-heating. This makes it very desirable to use non-condensing engines. The question of safety is more paramount in the isolated plants of department stores, office buildings and hotels, public and private buildings. Therefore, very high steam pressures are not to be recommended, however desirable from an engineering standpoint. We shall therefore confine this treatment to the economies indicated by best modern practice in the steam engineering of central stations for electrical supply.

Here the designing engineer has a freer range, but is confronted with more serious obstacles. It is the problem of equipment. This is not a question merely of sizes of units best adapted to the work in hand. It is rather a question of the selection of suitable types of motive power machinery, of accessories and of the appliances most conducive to economy, all of which are to be installed with due attention to the recognized economics of arrangement, and operated according to the now well-known methods of economic working of steam. A further analysis of this problem, as we have previously shown, leads to the primary question of the quality of the steam during admission and expansion and at the point of release. Indeed, all other things being equal, it may be said that it is that manner of working the steam which insures at the point of release dry cylinder walls, which is really the vital and determining factor.

From the condition of the steam which insures dry cylinder walls at the point of release, we may trace back the events and accompanying heat changes to the steam admitted to the cylinders in the first place. We shall find that a steam jacket on the low pressure cylinder will be conducive of greater economy, for instance, than if placed on the high pressure cylinder. Reheating receivers between the cylinders may also be found to be valuable adjuncts to the steam jackets. In the first case, the additional heat supplied by the reheater to the working steam is at that stage of the process when it is most beneficial; namely, in its passage from the high-presure to the low-pressure cylinder. In the second case, the heat supplied continuously by the jackets of either cylinder will be found to be of the greatest alvantage during the time of admission of steam to the cylinder; for even the unjacketed cylinder frequently shows a profitable heat interchange during the process of expansion when it imparts some of the heat in its cylinder walls to the expanded steam. Farther back than this, however, we shall find that it is quite possible to store such a sufficient amount of heat in the steam at the boiler that almost all condensation losses in the high pressure cylinder shall be prevented. This last consideration brings us to the question of superheated steam.

In American steam-boiler practice the degree of superheating that is reached is more frequently that due to the structure of the boiler itself than to any especial means provided for superheating. Almost all vertical boilers and several water-tube types will superheat the steam from 10 to 20 deg. F. Such are the standard types of construction adopted by nearly all makers of so-called superheating steam boilers. After the steam leaves the water drum it usually passes through a separate steam drum, or through tubes exposed to the hot gases and other products of combustion on their way to the chimney. This results in slightly superheating the steam and so far is an effort in the right direction. If engineers demand a higher degree of superheat, it will no doubt be provided by designs adapted to further utilize the heat of the chimney gases. Heretofore, practical defects in the design and construction of superheaters have resulted in their early abandonment, if they have not actually prevented their introduction.

Within the slight range of superheating of from 10 to 20 deg. F., there is scarcely any marked benefits. Superheated steam to be effective in increasing economy should have very much higher temperatures than that of the saturated steam from which it is formed. In fact, the superheating should be carried to such an extent (from 100 to 300 deg. above the temperature of evaporation) that the result is a true steam-gas. Of course, this cannot be effected in connection with existing devices. Such superheated steam cannot be formed in contact with the water from which it has been evaporated. The injurious effects of superheated steam on the cylinder walls, piston rods, valves and packing can now be more efficiently obviated than in the past. The question of lubrication at these high temperatures can be satisfactorily met by the use of mineral oils.

For some reason or other, builders of stationary engines generally prefer not to jacket their cylinders; however, they will do so to meet engineers' specifications. Many have experimented in this direction and have come to the conclusion, whether wise or otherwise, that the complications and increased attention required of cylinder jackets more than off-set the possible gain. In almost all cases in which jackets are used in compound and triple expansion engines, provisions are made for using live boiler steam directly or through reducing valves. This throws the efficiency of the jacket into the hands of the operating engineer. It will be seen, therefore. that conditions may arise in which the jackets will be positively detrimental, resulting in wetter cylinder walls at the point of final release of the exhaust steam than would otherwise occur without the use of jackets.

Partly to counteract the ill effects of cylinder condensation in the high-pressure cylinders and further to reheat (and possibly to superheat slightly) the steam before reaching the low-pressure cylinder, as well as on account of their practical operation being more conducive to economy than that of steam jackets, we find that reheating receivers have come into quite extensive use. Compound engines with efficient reheating receivers have repeatedly shown themselves to be almost as economical as triple-expansion engines working within the same limits of steam pressure and with the same number of expansions. This is not the only argument, however, for reducing the number of cylinders for electric light engines, for it has been determined by experience with variable loads, that the compound engines will meet these rapid changes with less reduction in economy than in the case of triple-expansion engines.

Moreover, the cross-compound condensing engine with reheating receiver is a type particularly well adapted to drive electric generators. The structural advantages are many, particularly of the horizontal type. All of the electrical equipment of such an outfit may be placed in one large generating unit mounted on the engine shaft between the two cylinders. In vertical types of compound engines this central mounting is not so desirable on account of oil and water drippings, so that the dynamos are preferably placed on the outside of the cylinders on the overhanging ends of the crank shaft.

The engineer can determine beforehand the probable economic performance of any proposed plant. In the case of pumping plants the duty can be so closely approximated that both parties willingly enter into a binding contract on such a basis. A subsequent contract trial serves to determine how far the installation satisfies the guarantee of a specific performance. The whole business of electric power plant design, construction, installation and management is in a formative period. It is, however, rapidly attaining its majority. The growth should be along recognized engineering lines, a careful predetermination of performance, a binding contract on this basis and a thorough trial for fulfilment of guarantees.

The electric plant, though operated in practice under extreme and rapidly-varying loads, may still have its economic performance guaranteed, contracted for and tested at certain specified and uniform loads. Such contract trials may be readily conducted without being made needlessly elaborate and expensive. It is only required to determine the electrical output at the switchboard, in kilowatt hours, for a given input of pounds of feed water or of heat units in the feed water. Extreme simplicity and a high degree of accuracy are attainable in making such measurements in electric power plants. Though the daily operation of the plant will be under widely different conditions from those under which the contract trial is made, still there is a possibility that at least the efficiencies, economies, guarantees and contracts now being realized in pumping stations should be much more nearly approached by the modern electric power plant. For beyond a thousand horse-power the variable charges become more uniform, notwithstanding the load variations which produce them.

A FACTORY POWER AND HEATING PLANT.

Among the recent additions to the list of electrical transmission plants is that of the McMullen Woven Wire Fence Company, which has just completed a new factory in West Evanston, Ill., for the manufacture of woven wire fencing. The plant comprises two buildings, a main factory building 540 ft. long by 110 ft. wide, and a power house 58 ft. long by 48 ft. wide. The power house is located some 40 ft. west of the main building, the intervening space being used for side tracks for receiving and shipping purposes. Coal is shoveled directly from cars into the coal-storage bins in connection with and made a part of the boiler room.

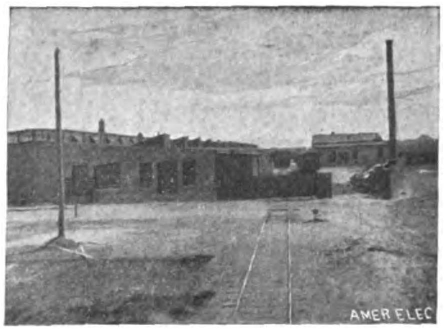


FIG. 1.—VIEW OF PLANT, SHOWING POWER-HOUSE ON THE RIGHT.

The power house is built entirely of brick, with an iron truss roof, and is divided into boiler and engine rooms. The engine room contains at present one generating unit and one ventilating unit used in connection with the heating system, together with all accessories. The generating unit consists of a 13-in. x 12-in. simple "Allfree" engine, directly connected to a 60-k.w. 120-volt "Excelsior" dynamo running at 275 r.p.m. The ventilating unit is composed of an 8-in. x 8-in. simple engine directly connected to a three-quarter housing, 120-in. bottom horizontal discharge fan, running at 225 r.p.m.

The engine room was laid out with space for another direct-connected generating unit for future expansion. Connecting the engine room with the main building is a tunnel 4 ft. wide by 4 ft. 6 ins. high, through which are carried the main steam supply and return pipes for heater stack, the mains leading from the switchboard to the center of distribution in the factory, and also the air discharged by the fan.

The boiler plant consists of two 66-in. x 18-ft. horizontal tubular boilers, fully equipped with all modern accessories, including "Roney" mechanical stokers. The latter, after a most severe test, have proved entirely satisfactory under all conditions of firing.

The chimney is self-supporting and of steel plate with a full lining of fire brick, having an internal diameter of 44 ins. and a height of 90 ft. above the grates. The general view of the factory and grounds, Fig. 1, showing power house in the distance, was taken with the plant in full operation.

The main building is of the ordinary mill construction with brick walls and roof and supports of wood. The large amount of window area makes the building very light at all points. At night the factory is lighted with twenty inclosed arc lamps manufactured by the Adams & Westlake Company, each lamp consuming 5 amps., with a difference in potential across the carbons of some 80 volts. These lamps have given excellent satisfaction throughout, giving a brilliant white, steady light. In addition, each machine is provided with a number of incandescent lamps for individual lighting, there being in all about 200 incandescent lamps.

The switchboard, which does not show in the cut of the engine room, is located about 3 ft. from the wall and a little west of the dynamo, it being intended that when

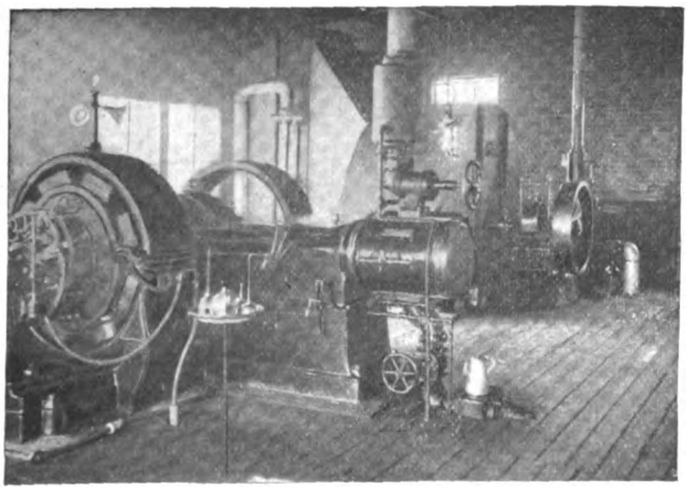


FIG. 2.—VIEW OF GENERATOR ROOM.

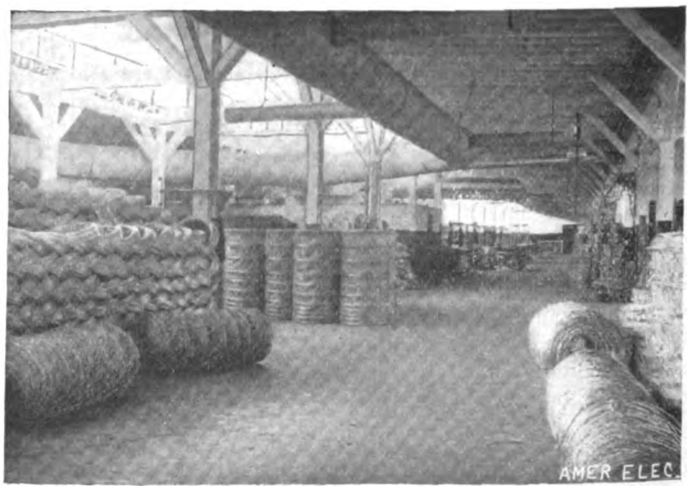
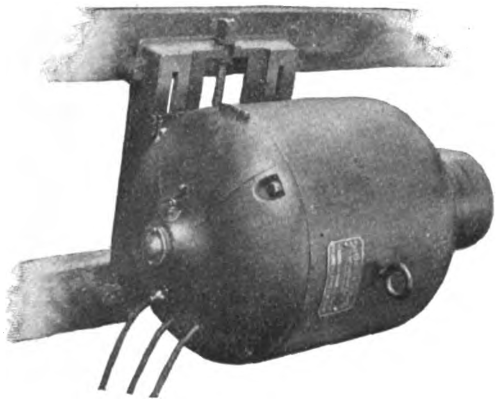


FIG. 3.—SHOWING HEATING SYSTEM.

another direct connected generating unit is added the switchboard shall be equi-distant from both generators. From the switchboard two circuits are run to the center of distribution in the main building for power distribution and one circuit for lighting. From this point, four circuits are run for power, to one of which each motor is tapped indirectly, while for the lighting sub-centers are used. The maximum drop in voltage under full load to the most remote machine is 5 volts, and the dynamo is over-compounded to compensate for this drop.

The machines operated consist of looms and banks of "winders"; the product of the looms from the lightest poultry netting to the heaviest railroad fencing. This product is made in any width up to 96 ins. Stacks of so-called "railroad fencing" may be seen in the foreground of the cut showing the general interior. In most cases a 2-h.p. shunt motor is used to operate the machines, but the heavier machines require 4-h.p. motors. Each loom has an individual motor mounted on and a part of the machine.



The winders are arranged in groups and are operated by 4-h.p. motors of same type as is used for operating the heavy looms, the motors being mounted on platforms overhead and belted to line shafts about 18 ins. from the floor. The motors used throughout this plant are of the entirely inclosed type (Fig. 3), manufactured by the Thresher Electric Company.

The entire factory building is heated by a forced blast heating system, which was designed so as to maintain a temperature approximating to 70 deg. F. in the factory, with a minimum outside temperature of 10 deg. F. below zero. The fan, to which reference has already been made, has a capacity of delivering some 25,000 cu. ft. of air per minute through a system of ducts into the factory building. Before passing into the fan the air is drawn over a tempering coil containing approximately 500 sq. ft. of heating surface, which under the extreme conditions of temperature, will heat the air to some 20 deg. F., and at this temperature the air is forced through the underground tunnel underneath the railway tracks and rises through a galvanized iron duct in the factory building, running overhead to the main heater stack chamber.

In this heater chamber there are two heater stacks with a combined radiating surface of some 1450 sq. ft. Each of these stacks is subdivided into four separate sections, each individual section having its own steam and return valve; the entire arrangement being such that any section may be cut out or in independently of any other. A novel system of damper control has been devised, the arrangement being such that either one or both of the heater stacks may be by-passed, or in case of an accident happening to either of the stacks all of the air may be forced through the other stack and at the same time be evenly distributed, so that each end of the building will get its proper amount, or one end entirely cut out and the air forced through both stacks to the other end of the building.

After the air passes through the heaters it is distributed to all parts of the building, one main 36-in. duct leaving the north and south sides of the chamber respectively, these being subdivided as they leave the chamber into distributing ducts leading to branches on either side of the building. There is thus a complete system of main distributing ducts running the entire length of the building on either side. From these main ducts the heated air is delivered to the building by branch ducts, delivering the air toward the outside or coldest wall, with the exception of a few which are arranged to deliver the air into the lantern of the building. Each and every branch duct is provided with a damper which, by means of cords, can be controlled from the floor. A general idea of the heating chamber and distributing ducts can be had by reference to Fig. 4.

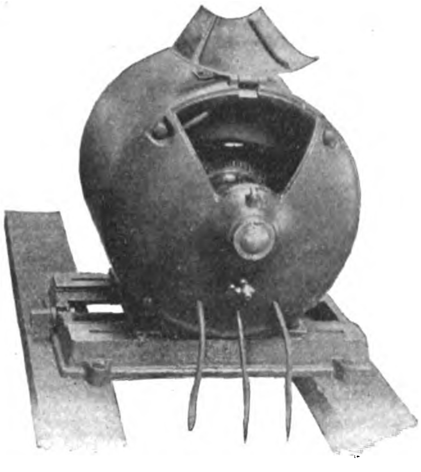
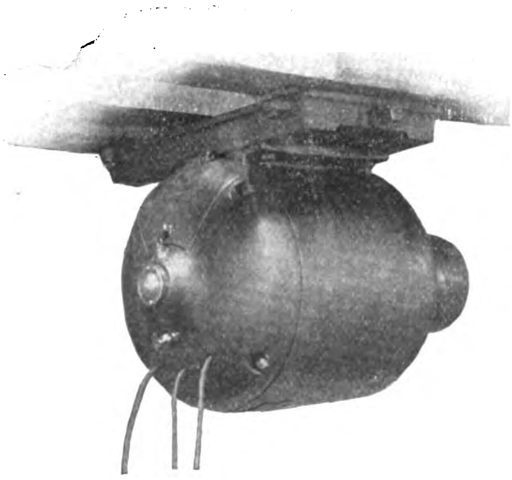


FIG. 4.—TYPES OF MOTORS EMPLOYED.

For heating the building, the exhaust steam from the dynamo engine, as well as that from the fan engine, is utilized and when this is not sufficient, as in extremely cold weather, the supply is supplemented by live steam. The exhaust steam from both engines and pump is first passed through oil separators and then enters the main exhaust header, carried underneath the floor of the engine room. This header is connected to an 8-in. pipe which is carried across to the factory building, where it rises and is connected to the headers of the heater stacks. In the exhaust header of the power station a pressure of 5 lbs. is maintained. The engines are thus working under a constant back pressure of this amount, the back pressure valve being set to open at approximately 5¼ lbs., while the pressure reducing valve connecting the high pressure header with this main exhaust is set so as to maintain the pressure in the heating mains at the predetermined pressure and is therefore weighted to open and admit live steam when the pressure falls below approximately 4¾ lbs. The return from the heater stacks in the factory building is connected to the return from the tempering coil in the power station, and the pipe is then led to and connected with a combined automatic pump and receiver, so arranged and connected as to deliver the hot returns either to the heater or to the boilers direct.

The entire plant has been so designed as to eliminate the possibility of delays due to accidents, as completly as possible, and is operated very smoothly and economically, for which credit is due the engineers, Messrs. Pierce & Richardson, who not only designed the entire system, but also have had complete superintendence over the installation. To these gentlemen we are indebted for the information contained in this article.



ALTERNATING-DIRECT CURRENT GENERATORS.

A system of current generation which is of comparatively recent growth is that in which an alternating current and direct current machine are combined into one. The chief advantages to be derived from the use of this system are found in connection with long distance electric railways where the power plant is located near the railway. In such a system it is desired to supply direct current from the power station, directly to the railway, and also to supply direct current from sub-stations at distant points on the line, the sub-stations being themselves supplied from the main generating station.

Direct current is supplied to the feeders from the "direct current end" of the generators; and alternating current, taken from the other end at a comparatively low pressure, passes through suitable step-up transformers and high tension lines to the various rotary transformer sub-stations, supplying the more distant sections of the railway.

The advantages in this case over the installing of both direct current machines and alternators in the power stations, are, uniform type and size of generators, less reserve machinery required, and more uniform load on generators and steam engines.

These machines may also be used when direct and alternating currents are required from the same station for power and lighting work. The generator is essentially a direct-current machine, with the number of poles and speed proportioned for the frequency of alternation required, and provided with suitable collector rings connected to the proper points of the armature winding for taking alternating current from the same winding.

The armature is of the same general form as that of a rotary transformer. The direct current voltage corresponds to the maximum alternating current voltage; while the mean alternating current voltage, as indicated by the voltmeter, is about .71 of the direct current voltage for two-phase machines, and about .61 of the latter for three-phase machines.

The first machines of this class were constructed by the Westinghouse Company in 1894 for the Citizens' Light and Power Company, of the city of Rochester, N. Y. These dynamos are provided with both shunt and series field windings, the shunt winding being always connected across the direct current brushes. When the machine is operated to produce direct current alone, the main current passes through the series winding as usual. When working as an alternating current generator, the regulation is effected by means of the rotary transformer at the sub-station, if the rotary is compounded, by having the direct current pass through the series winding. This increases the e.m.f. of the generator, as well as that of the rotary, thus giving an increased direct current e.m.f. as the system is located.

The armature core is built up of thin steel discs, and the coils are shaped and thoroughly insulated before being placed in the armature slots. The field core is built of thin steel plates, cast into the iron yoke or frame of the machine; thus producing an extremely powerful magnetic field, while the losses due to eddy currents caused by armature reaction, are eliminated by the use of laminated poles.

The generators are wound to over compound about 10 per cent, when used as direct current machines. They can be used to give both currents at the same time, but when so used, they will not of course regulate for both loads.

The Westinghouse Company has installed a large number of these generators and the results have been satisfactory. The latest application of the type is at the generating station of the Lewiston, Brunswick & Bath (Me.) electric railway. This road is to cover nearly thirty miles of steep grades and sharp curves, and the system here described is to be used exclusively.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Starters for Gas Engines.—In a short article in the (London) "Electrical Review" Mr. W. H. Booth speaks of the difficulties of starting large gas engines, and suggests that each be equipped with a small starting engine which can be itself started by hand. In electric light stations, etc., where there is a supply of electricity and the engines are coupled or belted to dynamos they may be started by using the dynamo as a motor, or they may be equipped with a starting motor. He objects to the compressed air starting mechanisms, depending on a store of air pumped up by a former run of the engine as likely to fail, especially in the case of engines using poor gases, and seems to think that the problem is one of great importance, as the difficulties of starting such engines promptly have limited their use.

A Singular Accident.—According to "L'Electricità," a singular and fatal accident recently occurred at Basle. Early one morning a young man walking along the street was struck in the neck by a fallen telephone wire that lay across the overhead trolley wire of the street railway and was grounded at the other end by a metallic structure. The wire was traversed by a heavy current and was at a low red heat. Between the burning and the shock the young man lost his footing, fell forward so that his weight rested upon the red hot wire, and was completely decapitated by it. Our Italian contemporary thinks that this accident will help the adoption of a two-wire alternating current railway system.

Frequency Measurements.—A very novel method of measuring the frequency of alternating currents is described by Mr. C. Kinsley in the "Philosophical Magazine." The apparatus consists of a telephone receiver and an air column of adjustable length contained in a drawn brass tube having a closely fitting piston. The telephone is inserted in the alternating circuit and the tube is placed in front of it, the distance between the receiver and the tube being about half the diameter of the latter. Whenever the length of the air column is suitable there will be a reinforcement of the note of the telephone, this applying as well to the harmonics present as to the fundamental. The frequency of the latter is always a simple function of the frequency of the successive harmonics, being the greatest common divisor of their various frequencies. Before calculating the final results correction must be made for the diameter of the tube (by adding 0.41*d* to the length) and for temperature. The author states that brass tubes about 1.5 inch in diameter are most durable and convenient. He found that the natural period of the diaphragm of every telephone on the market is too high to affect sensibly the alternating current harmonics.

A Simple Adaptation of the Coherer.—In the forms of wave-telegraph apparatus hitherto used a vibrating mechanism of some sort has been used to restore the coherer after it has "cohered." Usually this apparatus has taken the form of an electromagnetic vibrator or tapper, arranged to continually tap and jar the coherer tube. For various reasons this arrangement has not proven satisfactory, and Morse signals have been found to be too little separated by such a receiver for distinctness. Dr. H. Rupp describes, in "Elektrotechnische Zeitschrift," an arrangement for loosening the cohered filings, which is said to be as effective as it is simple. The coherer tube is provided with straight terminal wires and a small pulley, so that it can be rotated by the motion of the paper strip of the Morse register. The diameter of the coherer tube, for good results, must not be too small, and the quantity of filings should be such that they will roll around on the walls of the tube between the two electrodes. The diagram shows the arrangement of a receiving station. In circuit with the coherer tube F is a battery E, relay R, and resistance W. The plug switch U throws the calling bell L or the Morse register M into circuit with the relay. The local battery is indicated at B, adjusting resistances at W_2 and W_3, while W_4 is a resistance around the relay to prevent its sparking.

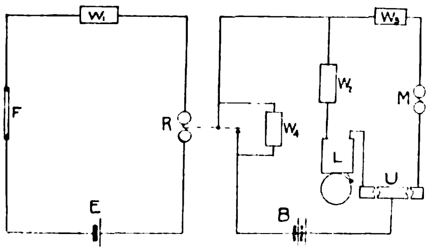
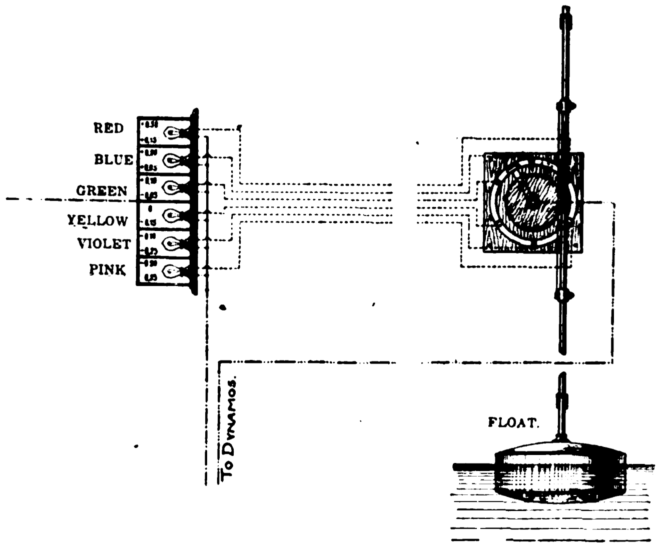


DIAGRAM OF COHERER CONNECTIONS.

Alternating Current Arc Lamp.—An interesting regulating mechanism for an alternating current arc lamp has been brought out by a German firm and is illustrated and described in "Elektrotechnischer Anzeiger." At the top of the lamp a disc of aluminum turns on a horizontal axle to which is connected, through a train of gearing, a drum carrying a chain of which the two ends are attached to the upper and lower carbon holders. Two horseshoe electromagnets embrace the aluminum disc, one being energized by the main current, while the other is connected in shunt around the arc. The effect of the alternating field of these magnets is to cause currents displaced in phase from the main current to flow in the disc, which tends to revolve under the action of the two magnets and these currents. When the arc is of normal length the effects due to the two magnets balance and the mechanism stands still. When the arc is either too long or too short the disc rotates and moves the carbons into the proper position. Both the upper and lower carbons are of the same size and length, and the arc is maintained constantly at the same place. An enameled reflector having a hole in it for the upper carbon is suspended just above the arc, thus increasing the horizontal and downward intensity of the light.

Electric Water Level Indicator.—In a paper in "Zeitschrift für Elektrotechnik" describing the water-power installation for lighting Hermannstadt, Herr Oscar von Miller illustrates a simple water level indicator which is installed in the reservoir above the turbines and serves to continually indicate the water level to the switchboard attendant. The construction of the machine is clearly shown in the accompanying illustration. Attached to the vertical rod of the float is a cord wrapped around a drum to which is attached an arm sweeping over the switch sectors of a simple commutating arrangement. To this is connected a bank of lamps, of various colors, one of which is always burning. The color and position of the illuminated lamp are a continual index of the height of the water, an alarm apparatus also being included in circuit with the lamp that marks a dangerously low water level. An apparatus of this character is so simple and easy to make that it can be installed in almost any station worked by water power.



ELECTRIC WATER LEVEL INDICATOR.

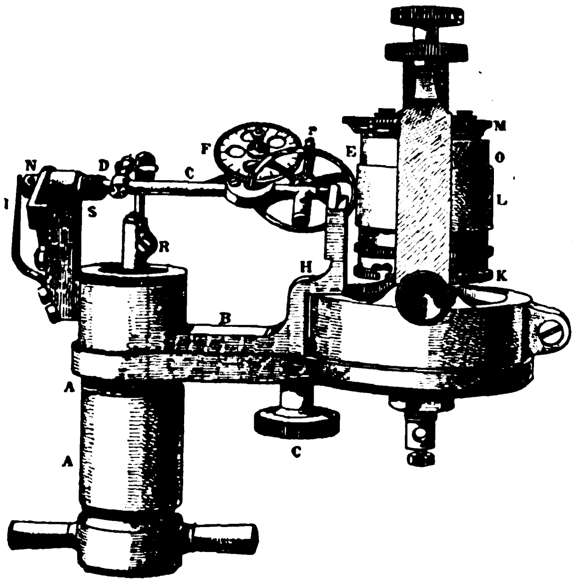
Electrolytic Glucinum.—This interesting metal possesses some properties which make the discovery of a commercial process for its reduction highly desirable. Its specific gravity is 2, electrical conductivity almost equal to that of silver, and it is practically unoxydizable. "L'Eclairage Electrique" contains an interesting note describing the various processes that have been attempted for its reduction. Of these the most recent is that of M. Lebeau. As electrolyte he uses one of the double fluorides of glucinum and sodium,

$$GF_2 2NaF \text{ or } GF_2NaF,$$

which he obtains either by mixing together concentrated solutions of the two fluorides which are then allowed to crystalize, or by dissolving glucinum hydrate and sodium carbonate in proper proportions in hydrofluoric acid. Of the two salts the one less rich in sodium is preferred, as its conductivity is the higher. The electrolyte is melted in a nickel crucible by means of a Bunsen burner, the heat being stopped when it is completely melted. A small carbon rod is used as anode and the crucible as cathode, the current being regulated so that the temperature does not exceed a dull red heat. A metallic non-adherent deposit forms on the crucible, which may be separated from the mass by boiling water. After many washings this deposit becomes completely dissociated as a powder of very irregular crystals of pure glucinum. By using a carbon crucible containing a stratum of a melted metal glucinum bronzes have also been made by this process.

Novel Properties of Rontgen Rays.—In a recent communication to the Berlin Academy Professor Röntgen described some new properties of the X-ray, which are of considerable interest. If a fluorescent plate is covered with a screen completely opaque to the rays a slight fluorescence can still be seen when the tube is in action. This is due to diffused X-rays proceeding from the air of the room, which itself emits the rays wherever it is exposed to their action. Of the rays which are given off by the platinum plate of a focus tube those are most effective for producing radiographs which leave the platinum at as great an angle as possible within a limit of 80 deg. The specific transparency of bodies is variable, being greater as the thickness of the body increases. The ratio of the thickness of two equally transparent plates of different material is dependent on the thickness and the material through which the rays pass before impinging upon the plates. The contrast between bodies of different transparencies depends upon the e.m.f. used to excite the tubes. A spark gap in the secondary circuit acts in the same way as an interpolated Thomson transformer, both producing more intense and less easily absorbed rays. With such a transformer and wire electrodes in a narrow tube X-rays can be produced with a vacuum of 3.1 m.m., the usual vacuum being about 0.002 m.m. Tubes requiring a very high e.m.f. for the production of the rays can be made active for lower pressures not only by heating, but also by passing through them a very powerful discharge. — "Electrotechnische Zeitschrift."

An Integrating Indicator.—It is often desirable to register the total power developed by an engine over a period of time. The usual method of taking many indicator cards and averaging these leads to troublesome calculation, with opportunity for error, and considerably increases the labor of the test. A new form of indicator that continuously registers the i.h.p. of the cylinder over the period of time during which it is in operation has been designed by Messrs. Little, and is described in "Engineering." Its construction is clearly shown in the accompanying illustration. The cylinder A and the piston working against a spring are similar to those of the ordinary type of indicator. Above the cylinder is an oscilating axle, C, carrying the counter F and a planimeter wheel, E. This is held in contact with the surface of the drum, O, by a spring and its inclination with respect to the elements of the drum surface varied by the motions of the piston. The counter consists of two wheels, one having 99 teeth and the other 100, engaging with an endless screw on the arbor of the wheel, E. This gives the apparatus a capacity for registering a large number of strokes. On the upper part of the drum is another counter, M, which registers the total number of strokes. It is stated that this ingenious apparatus has given excellent results in practice.



AN INTEGRATING INDICATOR.

Capacity and Discharge Rate of Accumulators.—A very interesting article in "L'Eclairage Electrique" give the results of the recent researches of Herr W. Peukert and M. F. Loppé upon the relation between the discharge rate and capacity of lead accumulators. It is well known that as the discharge rate rises the capacity of the cell in ampere hours falls, or that a cell having a certain ampere-hour capacity at a ten-hour discharge rate has a considerably less capacity when it is discharged in a shorter time. The relation between the time of discharge and the capacity can be expressed by the formula.

$$I^n t = k$$

where I is the discharge current, t the time of discharge and n and k constants of which the value is determinate for a given cell. The value of n depends upon the type of cell, while k depends upon the size of the element considered.

If for each type of accumulators the discharge current corresponding to a ten-hour discharge be taken as the unit, ten hours being taken as the unit of time, then for a time of discharge such that $t_1 = ta$ the current strength x will be given by the formula

$$x^n a = 1$$

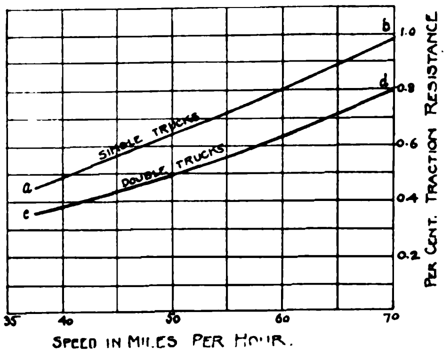
Similarly, an element having a capacity C for a time of discharge t, would have a capacity Cax for a discharge in time t_1.

As formulae requiring the use of exponentials are difficult of application, a table is given showing values of the capacity for discharge rates varying between 20 hours and 15 minutes for a number of values of n.

Time of Discharge in Hours.	Ratio of Capacities. Capacity at 10 Hours Discharge as Unit.									
	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2
20	1.065	1.122	1.173	1.219	1.260	1.297	1.330	1.361	1.389	1.414
18	1.056	1.103	1.143	1.183	1.216	1,247	1.274	1.303	1.321	1.342
16	1.044	1.081	1.115	1.144	1.170	1.193	1.214	1.232	1 249	1.265
15	1.038	1.070	1.098	1.123	1.145	1.164	1.182	1.197	1.212	1.225
14	1.031	1.053	1 081	1.101	1.119	1 135	1.149	1.161	1.173	1.183
12	1.017	1.031	1.043	1.053	1.063	1.071	1.078	1.084	1.090	1.095
10	1	1	1	1	1	1	1	1	1	1
9	0.991	0.983	0.976	0.970	0.966	0.961	0.958	0.954	0 951	0.949
8	0.980	0.963	0.950	0.938	0.928	0.920	0.912	0.906	0 900	0.894
7	0.968	0.942	0.921	0.903	0.888	0.875	0.864	0.853	0 845	0.837
6	0.955	0.919	0.887	0.864	0.844	0.826	0.811	0.797	0.785	0.775
5	0.941	0.892	0.852	0.821	0.794	0.771	0.752	0.735	0.720	0.707
4	0.920	0.858	0.810	0.770	0.737	0.709	0.686	0.666	0.648	0.632
3	0.896	0.818	0.758	0.709	0.669	0.637	0.509	0.586	0.566	0.548
2	0.864	0.765	0.678	0.631	0.585	0.547	0.515	0.483	0.467	0.447
1	0.811	0.681	0.558	0.518	0.464	0.422	0.388	0.359	0.336	0.316
¾	0.790	0.649	0.550	0.477	0.422	0.379	0.344	0 316	0.293	0.274
½	0.762	0.607	0.500	0.425	0.368	0.325	0.291	0.264	0.242	0.224
¼	0.715	0.541	0.427	0 349	0.292	0.251	0.219	0.194	0.174	0.158

It is evident that the value of n for an ideal accumulator, or one in which the capacity does not diminish as the discharge rate rises, would be 1.

Traction Resistance.—For some time past experiments have been in progress in a French railway to determine the coefficients of traction of various types of cars at very high speeds, and these results have been published in the "Revue Générale des Chemins de Fer." The results of greatest interest to the electrical fraternity are those obtained for 4-wheel rigid truck cars and 8-wheel double (bogie) truck vehicles. Measurements were made under all sorts of conditions of track and weather, and the data below are the means of numerous results, taken in all cases on a straight and level track. A dynamometer between the tender and the train coupling on fast expresses in all sorts of service for six years gave the figures from which they were deduced. Where V is the speed in miles per hour the value of the traction coefficient in per cent. of the total weight is for the 4-wheel cars:



CURVES OF SPEED AND TRACTION RESISTANCE.

$$.016 + .074\ V \left(\frac{1.6\ V + 50}{10000} \right)$$

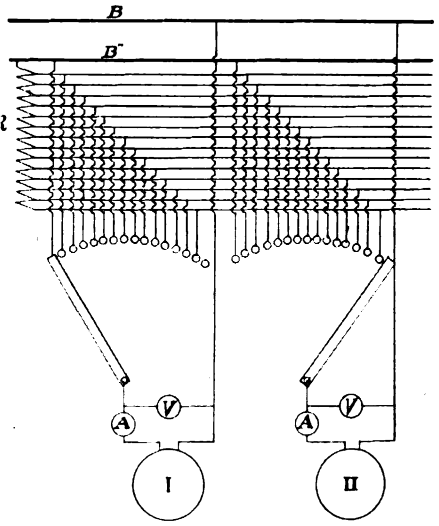
and for the double truck cars :

$$.016 + .074\ V \left(\frac{1.6\ V + 10}{10000} \right)$$

These are equations of parabolas, which are plotted in the accompanying curves, *a b*, representing the resistance of the 4-wheel type and *c d* that of the double-truck type at various speeds. The speeds are plotted as abscissas and the per cent. traction efforts as ordinates.

Electrical Conductivity of Glass.—Professors Andrew Gray and J. J. Dobbie recently read before the Royal Society a paper on the connection between the electrical properties and the chemical composition of different kinds of glass. Experiments were conducted to determine the circumstances that affect the conductivity and specific inductive capacity of glass, specimens being used that were richer in lead oxide than any formerly available. It had already been shown that potash and soda lime glasses have a higher conductivity than flint glass, and the experiments of the authors showed that the conductivity decreased with the increase of the lead oxide and the decrease of the soda, as had been expected.

Parallel Working of Alternators.—A simple method of paralleling single-phase alternators is described by Dr. J. Sahulka in "Zeitschrift für Elektrotechnik." The object of the method is to avoid increasing the load on the station by the use of an artificial load in the circuit of the machine that is to be connected to the bus-bars. A resistance, sufficiently high to permit the passage of only a few per cent of the output of one of the dynamos when short-circuited across the bus-bars is provided and connected to one of the bars as shown in the figure. This resistance needs not be entirely ohmic, but the part of it remote from the bus-bar connection can be inductive. The wire of which the part near the bus connection is composed should be large enough to safely carry the full output of one dynamo. From a number of points in this resistance wires are led along the switchboard parallel to the bus-bars, and these are connected to points as shown. One terminal of each alternator is attached to the switch lever and the other terminal is connected to the bus-bar. This apparatus permits the machines to be brought into the proper relations for parallel connection by simply advancing the switch of the incoming machine from point to point while reading the ammeter and voltmeter and manipulating the field rheostat so that the load is properly divided between it and the other machines at the time of its full connection to the working circuit. By this arrangement the load on the station is not increased. When the voltage of the incoming machine is properly regulated and all the resistance is in there will generally be a small current flowing due to phase differences between the machines. This current tends to bring the machines to synchronism, the tendency increasing as the resistance is removed, until the machines are in perfect synchronism when the resistance is all out. For disconnecting the same process is gone through in reverse order. A quick break switch would work well for this purpose, however. It is stated that the same apparatus works equally well for direct and three-phase currents.



PARALLEL CONNECTIONS FOR ALTERNATORS

E.M.F. of the Arc with Aluminum Electrodes.—It is known that an electrolytic cell having carbon and aluminum electrodes opposes the passage of current in the aluminum-carbon direction with an e.m.f. of 22 volts, while current passes in the other direction with only the opposition due to the resistance of the liquid and the polarization e.m.f. Herr V. von Lanz describes in "Wiedmann's Annalan" his researches upon the arc with aluminum electrodes. This arc is established under an e.m.f. of 19 volts. Between electrodes of aluminum and carbon the current passes more easily from aluminum to carbon, an effect contrary to that noticed in the electrolytic cell. This arc may be used, therefore, for the rectification of alternating currents, but the efficiency of such a rectification would not be higher than about 6 per cent.

Lead-Zinc-Cadmium Accumulators.—An article in "L'Industrie Electrique" gives the history of the lead-zinc accumulator and describes recent progress toward the perfection of this interesting type. In accumulators of this class the electrolyte is a solution of sulphates which deposits, under the action of the charging current, a coating of zinc and cadmium on the negative plate. The positive plate is the usual lead peroxide grid or formed plate. At full charge the liquid contains a solution of sulphuric acid, which redissolves during the discharge the metal deposited on the negative plate. This combination presents several marked advantages over the ordinary type of secondary batteries, among them a higher e.m.f. and a greater specific capacity, by reason of the diminished weight of the negative electrodes. As a consequence of these qualities the specific energy of this type is considerably higher than that of the all lead variety, and for certain applications this is a matter of extreme importance, as in the case of automobile vehicles. On the other hand, it is difficult in this type of accumulator to secure a good and solid deposit of metal on the negative elements, and the zinc thus deposited dissolves in the acid solution on open circuit with loss of energy. To stop this local action an early remedy was the reduction of the size of the negative element and its amalgamation. The recent improvements due to M. Werner seem to have made this type of accumulator very practical. As electrolyte he uses a mixture of the sulphates of zinc, cadmium and magnesium. During charge a deposit of zinc and cadmium is thrown down on the negative plate and a certain quantity of hydrogen is disengaged, which is said to enter into combination with the deposited metals, or, more properly, to be absorbed by them. During discharge the metals dissolve, the effective e.m.f. ranging from 2.3 to 1.9 volts. With a strong solution of zinc sulphate a good deposit of metal may be had, but the positive plate does not properly oxidize. With a solution of cadmium sulphate the oxidation goes on correctly, but the e.m.f. falls from 2.4 to 1.8 volts, after only 1/10 the total current is discharged. M. Werner found that in the presence of magnesium sulphate the deposit of zinc and cadmium is very regular and at the same time the functions of the positive plate are properly discharged. The charge is stopped when about 60 per cent of the salts are decomposed. On open circuit the losses due to local action depend on the nature of the bath and the quality of the metallic deposit. With a solution in which the cadmium salt is the largest element the loss is not more than 3 per cent. of the total charge per day. It is claimed that this type of cell has given results as good as 40 watt hours per pound of plates, or 16 watt hours per pound of complete cell.

Telephone Line Extensions.—In a rather elaborate article in "L'Eclairage Electrique" M. P. Heina gives a method of determining to what point of a system of cable main lines a subscriber's circuit should be connected. Taking first the case of a simple installation in which all the lines are overhead and no cable is used, each subscriber's line naturally runs direct to the exchange. If the crowding of the lines necessitates the establishment of a cable or substation, then the point of embranchment of the cable being selected, whether a given station should be connected to the exchange or the cable can be determined in the following manner. The average length of a subscriber's line is, for each installation, a definite amount greater than the air-line distance between the exchange and the station. Referring to Fig. 1, if P is taken as the ratio of these lengths, so that if C is the exchange and M the station, the actual length of the line is P. CM, the locus of points in which the relation

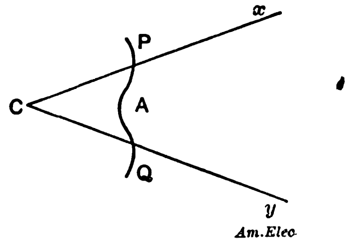


FIG. 1.—TELEPHONE LINE EXTENSIONS.

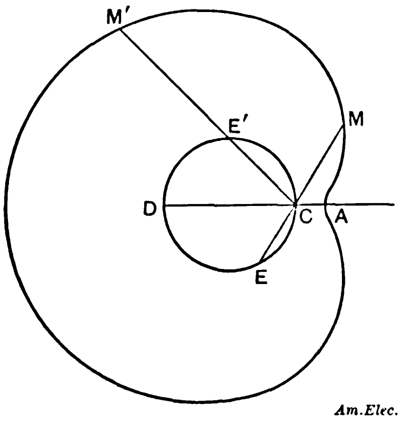


FIG. 2.—TELEPHONE LINE EXTENSIONS.

$$CA+AM=P.CM$$

holds good, where A is the end of the cable can be shown to be the curve AMM', which is a circular conchoid or Pascal's "limaçon." Its equation is, referred to C as pole and AC as polar axis,

$$r = \frac{2a}{P_2 - 1} \cdot (P - \cos \Theta)$$

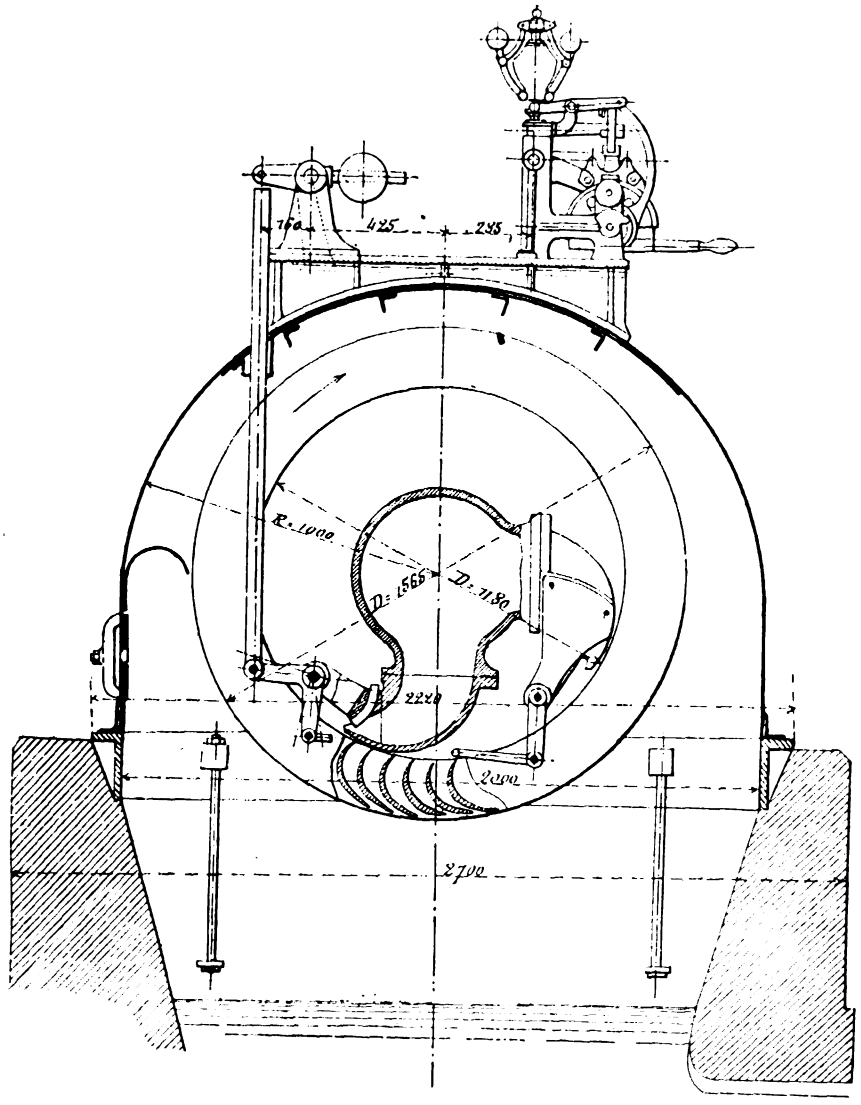
The circle CEDE' is the generating circle of the curve, and has for its diameter $\frac{2a}{P^2 - 1}$. In these equations a is the distance AC.

Referring now to Fig. 2 where xCy is any sector of the region served by the exchange containing a cable box A, the arc of this curve, PQ, can be easily constructed. All stations in the partxPQy should be connected to the box A and all stations in the area CPQ should be connected to the exchange. These principles can be readily extended to apply to a more complex system and furnish a guide that will easily determine the proper point for connecting in a subscriber so as to assure the maximum economy of line wire.

Lead Refining by Electrolysis.—Lead is never obtained in the pure state by the reduction of its ores. Apart from the bad effects that impurities have upon the quality of the metal, the foreign substances are frequently of value, as in the case of gold and silver. Two electrolytic methods for the separation of the foreign substances from lead are described by Mr. Sherard Cowper-Coles in the (London) "Electrical Review." By Keith's process the crude lead is cast into properly shaped anodes, which are inclosed in close fitting muslin bags. These are electrolysed in a solution of lead sulphate dissolved in an aqueous solution of sodium acetate. This mixture is made by electrolysing with lead anodes a mixture of 1½ pounds of sodium acetate, 2¾ ounces of sulphuric acid and 1 gallon of water, heated to 100° F. The lead deposited on the cathodes by this process is crystalline and continually separates from the plate, a space being left in the cell for its accumulation. When the anodes are dissolved the bags in which they were contained are emptied and the residual solid matter washed and remelted. The slimes suspended in the wash water are allowed to settle and the water drained off and filtered. These slimes usually contain antimony, arsenic, silver, copper, gold and iron.

The Tommasi process uses for electrolyte the double acetate of lead and sodium or potassium. The anodes are crude lead and the cathode, which is placed between two anodes, is a disc of aluminum alloy or copper half immersed in the liquid and revolving at the rate of one or two turns per minute. These discs are about 10 feet in diameter and ¾ inches thick. At the upper part are scrapers to detach the small, spongy crystals of lead, which fall into channels conveying them to wire gauze sieves, where they are drained and washed, the wash water being concentrated and again used as electrolyte. The lead is compressed, mixed with a few per cent. of charcoal powder and fused. The silver, with most of the arsenic and antimony, is separated at the anode and collected in trays to be fused with sodium nitrate and borax, by which the silver is separated from the other metals.. The cost of the process is estimated at from $1.60 to $2 per ton of lead when steam power is used.

A Spanish Lighting Station.—A very interesting electric light plant has recently been installed at Granada (Spain), and is fully described in "Génie Civil." Water power is used, the source being a torrent flowing from the glaciers of the Sierra Nevada. The power house is a little more than 6 miles from the city, at the foot of a gorge through which the stream descends. At a point about 3½ miles above a dam of concrete and masonry diverts the water of the stream into an open canal, through which it flows to a basin situated about 300 yards from the station. Thence it is conducted in a steel pipe 40 ins. in diameter to the turbines of the plant. These turbines are among the most interesting features of the installation. Working under a head of 325 feet, they develop 340 h.p. each at 350 revolutions per minute. The wheels are single and are overhung at the end of the wheel shafts. The water is admitted at two points in the interior of the moving part of the wheel, and acts both by impulsion and by the reaction of the outflow, as will be readily understood from the illustration. On the wheel shaft is a flywheel weighing 5,700 pounds. The couplings to the dynamos are of the Alioth insulated and elastic variety, and the alternators are very carefully insulated from the ground, being mounted on large blocks of porcelain. Around the dynamos the floor of the station is also insulated in the same way on porcelain blocks. Current is delivered by the generators at a frequency of 52.5 cycles per second (single-phase) and 4000 volts. The precautions against lightning and atmospheric discharges are very elaborate, as a singular phenomenon manifests itself daily. While it rains very rarely at Granada and the air is generally very dry, every evening at sunset there are strong atmospheric discharges on the high tension line. This is explained by the existence of a hill about 300 feet high near the middle of the 6 mile transmission line, the rest of the region traversed being flat. Great differences of atmospheric potential exist between the base and summit of this when the air on one side is warmed by sunshine, while the other is in shadow. The transmission line itself is of bare copper wire, about 0 gauge. At the outskirts of the town this is connected to a circuit of No. 4 wire, which runs completely around the town, and to which are connected 10 sub-stations transforming the current and feeding a three-wire system of 125 volts on each side. This circular feeder, notwithstanding the 4,000 volts pressure on it, is run entirely on house tops. It is to be regretted that our contemporary did not give more details of the method of mounting insulators and fixtures for this service.



TRANSVERSE SECTION OF GRANADA TURBINE.

A curious fact is noticed, on account of the larger part of the custom of the station coming from restaurants and drinking places, the load curve being unlike any other in Europe, and falling off very slowly until after 1 a. m. There are 5000 incandescent lamps fed by the installation and 40 arcs for street lighting, this being the whole extent of the lighting of a city of 75,000 inhabitants.

Submarine Cables in Time of War.—In an editorial the "Electrician" discusses at some length the question of the neutrality of cables in war with special reference to the probable attitude of this government and that of Spain upon the question of cables landing in the enemy's territory. It seems that there has been no war of importance since the establishment of the present widespread cable service to furnish precedents for the guidance of combatants in this very important matter, but the questions of neutrality that are concerned are out of place here. The most interesting feature of the article is the description of the cable lines landing in Cuba and Porto Rico and other Spanish possessions which it may be found necessary for our naval forces to destroy. It appears that there are four cables landing in Cuba, one from Havana to Key West, one to Hayti, and two to Jamaica. Porto Rico also has four cables, two to Jamaica, one to St. Thomas and one to the Danish island of Ste. Croix. The Philippine Islands possess one cable, to Hong Kong, which has already been severed by the American fleet, and the Canary Islands have two lines, one to Cadiz and the other to St. Louis in Senegal (Africa). It is pointed out by our contemporary that to cut this country off from communication with Europe it would be necessary to cut twelve cables in the North Atlantic, many of them ending in Canada, and three landing in Brazil, a contingency not in the least to be apprehended.

Electricity and Fire-Damp.—The safety of electric lights and other electrical apparatus in mines where there is much "fire-damp" and explosive coal dust has been studied at great length by MM. H. Couriot and J. Meunier, and the results of their labors presented to the Academie des Sciences. The general conclusions reached were that currents of methane, or mixtures of methane and air, cannot be ignited by an incandescent metallic wire or by the spark due to the rupture at an incandescent wire carrying a current. These mixtures are immediately ignited by a flame, and it was concluded that, for mine gases in motion, contact with a flame is necessary to determine ignition or explosion. With stagnant gases the results obtained were different. It was shown that incandescent wires cannot ignite even the most explosive mixtures, but that the spark due to the rupture of such a wire generally sufficed to explode the mixture. It seems that sparks of considerable volume and energy are required and that the incandescent light is the safest illuminant for dangerous mines.

A more important set of experiments was made recently by Herren Heis and Thieme in an artificial mine gallery supplied with gases from an abandoned working near Gelsenkirchen in Westphalia. The experiments on lamps were very complete. Naked filaments raised to high incandescence in an explosive atmosphere may or may not cause ignition, and may remain intact after the explosion. Lamps dropped to the floor and broken while burning sometimes caused an explosion and sometimes did not, though, with stout filament lamps such as are used with portable outfits, the filament sometimes survived the smashing of the bulb. The conclusion reached from some 200 experiments was that the ampere capacity of the lamps was the determining factor. Currents of less than 0.6 amp., continuous or alternating, did not cause explosion. Stronger currents mostly did. The advice given by these experimenters is to use stout globes and cages around the lamps for protection and to use low amperage lamps, but not to exceed 150 volts tension, as all excessive voltages are dangerous. Especial care should be taken with leading-in wires, etc., to avoid short circuits with their incidental flash. Arc lamps will not ignite coal dust, even in an atmosphere of methane unless the latter exceeds 6 per cent of the mixture, when an explosion is caused. Notwithstanding, arc lamps should not be used in fiery mines. Switches are dangerous when the current or e.m.f is excessive. Wire resistance coils are safe unless the wires touch and lead to internal sparking. For motors carbon brushes are safer than those of copper. A motor protected in a box with a fine wire gauze cover ignited the explosive mixture in the box on starting, but the explosion did not strike through the box. Induction motors were found to be very satisfactory and free from danger. The full report appears in "Elektrotechnische Zeitschrift" and an excellent abstract of it in "Engineering."

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ELECTRICAL PERIODICALS.

To the Editor of American Electrician:

I have read with interest the comments of Thomas D. Lockwood in your last issue on the subject of "Electrical Journals," giving the history of the three telegraph magazines published between October, 1852, and October, 1855. In one particular I think Mr. Lockwood is in error. Referring to "Shaffner's Telegraph Companion," the third and last of the publications mentioned, he says: "The first number is dated January, 1854, and the last October, 1855." This statement is correct only with reference to the octavo quarterly published by Shaffner between these dates in New York City. But during the previous year, 1853, Shaffner had issued two numbers under the same name in quarto form at Louisville, Ky. I quote from page 46 of the first number issued in New York, dated January, 1854:

> "The Telegraph Companion, as now issued, is an improvement on the old series, or original issue. The quarto form was inconvenient."

Also from p. 47, same number:

> "Old Subscribers.—The subscribers to the Companion during the last year can have their choice," etc.

In the next paragraph reference is also made to the change of publication office from Louisville to New York, and an apology offered for the delay, which had evidently been more than six months, as I find on p. 292 of the "American Telegraph Magazine," Vol. I., No. 6, dated July 15, 1853 (the last number published), the following:

> "After this issue 'Shaffner's Telegraph Companion' (of which two numbers were issued at Louisville), will be merged in the 'American Telegraph Magazine.'"

This plan of consolidation, however, was not carried out, as it is so stated in "Shaffner's Telegraph Companion" for January, 1854, on p. 48; but its publication was continued separately until October, 1855, as Mr. Lockwood states.

In this connection it may be of interest to present a table which I have compiled giving the "vital statistics' of American electrical journals that have ceased to exist. The causes of death are not stated. No doubt some died of natural causes, such as depletion of the bank account; others are said to have committed "journalistic suicide," a disease which seems to have had many victims, while not a few are reported to have been put to death by their charitable contemporaries.

I have included in the list no electrical periodical now published. The dates given have been obtained from the periodicals themselves in my own library, by correspondence with their former publishers and from contemporary references to them. I have included the telegraph journals, of which Mr. Lockwood has given the full history, so as to make the list more complete.

Name of Publication.	Publication Office.	Frequency.	First Issue.	Last Issue.
American Telegraph Magazine.	New York.	6 Nos. Only.	Oct. 1852	June 1853
National Telegraph Review [3]	"	4 Nos. Only.	April (?) 1853	Jan. (?) 1854
Shaffner's Telegraph Companion	Louisville.	2 Nos. Only.	— 1853	— 1853
" " "	New York.	Irregular.	Jan. 1854	Oct. 1855
Telegrapher	"	Monthly.	Sept. 26, 1864	Sept. 25, 1865
"	"	Semi-Mon'ly.	Oct. 16, 1865	Aug. 15, 1867
"	"	Weekly.	Aug. 31, 1867	Feb. 3, 1877
Telegraphic Journal	"	"	March 7, 1867	Nov. 1867
Operator	"	Semi-Mon'ly.	March 1, 1874	Oct. 1. 1882
"	"	"	Oct. 14, 1882	Dec. 30, 1882
"	"	[1] Sem-Mon'ly	May 1. 1883	Dec. 15, 1884
"	"	Bi-Weekly.	Jan. 10, 1885	Sep. 19. 1885
The Magnet	"	Semi-Mon'ly.	Feb. 14, 1880	[2] Sept. 15, 1880
Electricity	Cincinnati.	Monthly.	Sept. 1883	One issue (?)
Modern Light	Boston.	"	Jan. 1886	Dec. 1886
Continued as				
Modern Light and Heat.	"	"	Jan. 1887	Nov. 1887
" " "	"	Weekly.	Nov. 17, 1887	July 4, 1891
Continued as				
Electrical Progress and Development	"	Monthly.	March 1892	Dec. 1892
Street Railway Gazette	Chicago.	"	Jan. 1886	Dec. 1891
" " "	Chicago and New York.	Weekly.	Jan. 9, 1892	June 29, 1895
Continued as				
Electric Railway Gazette	New York.	"	July 6, 1895	March 28, 1896
" " "	"	Semi-Mon'ly.	April 10, 1896	June 25, 1896
Practical Electricity	Boston.	Monthly.	Aug. 1887	Dec. 1889
" "	"	Semi-Mon'ly.	Jan. 1890	[2] March 18, 1893
Electric Items	New York.	Semi-Weekly and Weekly.	April 21, 1888	[2] Oct. 6, 1888
Electric Power	"	Monthly.	May 1889	June 1896
Whipple's Reports	Detroit and New York.	"	Jan. 1889	[2] Aug. 1891
The Car	Philadelphia.	"	Oct. 1889	Dec. 1896
Electric Railway Advertiser.	Boston.	Semi-Mon'ly Monthly.	Oct. 15, 1890 Oct. 1891	Sept. 15, 1891 Feb. 1892
Continued as				
Electricity and Railroading	"	"	March 1892	[2] Feb. 1893
Electrical Northwest	St. Paul.	"	June 1890	Sept. 1891
Continued as				
Street Railway and Electrical News	"	"	Oct. 1891	[2] Jan. 1894
Electrical Enterprise	Boston.	Weekly.	Jan. 3, 1891	Jan. 16, 1892
Electric Spark	Chicago.	"	Jan. 1892	June 1893
Electrical Magazine	Washington.	"	Feb. 1893	[2] May 1893
Elektron	Boston.	"	Jan. 1894	One issue.
Electrical Literature	Chicago.	"	Jan. 1894	One issue.
Electrical Reporter	New York.	"	March 1894	5 or 6 issues.
Electrical Journal	Chicago.	Semi-Mon'ly.	June 1, 1895	June 1, 1897
Electrical Doings	New York.	Monthly.	April 1896	Feb. 1897

In addition to the above I append a list taken from the "Magnet" of Sept. 1, 1880, p. 113, giving the names of several infantile telegraph publications which were so short lived that it is doubtful if a single copy has been preserved. It is therefore impossible to verify names or dates. The list gives the following:

The Esquimaux (monthly; published by American Telegraphers in Russian America), 1866-7; eight or nine issues.
Telegraphica, New York, 1874; four or five issues.
The Fraternity, New York, 1874; two or three issues.
The Switch, Chicago, 1874; less than half a dozen issues.
The Plug, Cincinnati, 1874; one issue.
The Electric, St. Louis, 1875; two or three issues.
The Southern Operator, Bolivar, Tenn., 1878; one issue.
The Magnet (executed with the electric pen), Cincinnati, O., 1878; one issue.

If I am not mistaken, the editor of the "Esquimaux" was the late Franklin L. Pope, who was connected with a telegraph expedition to Alaska at that time. I have found several quotations from it and references to it in the contemporary volume of the "Telegrapher."

EDWARD CALDWELL.

New York, May 24, 1898.

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[1] From Jan. 6, 1883, to April 28, 1883, the "Operator" was not issued as a separate periodical, but formed a part of the "Operator and Electrical World." On May 1, 1883, it was resumed as a separate issue. After Sept. 19, 1885, it was continued as "Johnston's Journal."

[2] I have seen no later date than this, although a few more issues may have appeared.

[3] I have at hand for reference only one number, "Vol. I., No. 3, Oct., 1853, Quarterly."

The National Electric Light Association.

THE twenty-first annual convention of the National Electric Light Association is the seventh meeting of that body in the West, and the third in Chicago, its birthplace. The association was organized in Chicago, Feb. 25, 1885, with Mr. J. Frank Morrison as president, and its ninth convention was held there in February, 1889. The other Western cities in which conventions have been held are Detroit, August, 1886; Kansas City, February, 1890; St. Louis, February, 1893, and Cleveland, February, 1895.

A. M. Young,
First Vice-President.

Samuel Insull,
President.

George R. Stetson,
Second Vice-President.

Geo. P. Porter,
Secretary.

C. O. Baker, Jr.,
Master of Transportation.

Among the social features of the Chicago convention will be a reception at the Auditorium on Monday evening, June 6, an excursion on Lake Michigan, Tuesday, and coaching parties for ladies through the parks and boulevard system and suburbs, with luncheon, on Tuesday and Wednesday during hours of meeting.

The meeting of the executive committee will be held at 9 a. m. of Tuesday, and the convention will be opened at 10.30 a. m., with an address by President Insull. The remainder of the programme is as follows:

Tuesday morning—A paper by Mr. Calvin W. Rice, Brooklyn, on the "Cost of the Generation and Distribution of a Unit of Electricity." Topic for discussion, "Prices and Discount for Electric Current and Methods of Billing Current to Customers."

Tuesday afternoon—A paper by Mr. Alex. Dow, Detroit, on "Public Lighting with Relation to Public Ownership or Control." Topic for discussion: "Legislative Policy as to Public Service Corporations."

Wednesday morning—A paper by Mr. Herbert A. Wagner, St. Louis, on "General Distribution from Central Stations by Alternating Currents," to be followed by a paper by Mr. Louis A. Ferguson, Chicago, on "General Distribution from Central Stations by Direct Currents." Topic for discussion: "Standardizing Apparatus for Central Station Use."

Wednesday afternoon—A paper by Mr. W. McLea Walbank, Montreal, on "Cost of Producing Electric Power by Water Power from Lachine Rapids, Canada." Report of committee on standard candle-power of incandescent lamps, Dr. Louis Bell, Chairman. Topic for discussion: "Questions and Answers? What Is It You Wish to Know?" Executive session.

Wednesday evening—Lecture by Joseph Wetzler, New York, on "Electricity Direct from Coal," to be illustrated by stereopticon views.

Thursday morning—A paper by Prof. W. E. Goldsborough, Purdue University, Lafayette, Ind., on "Transformer Economy." Reports of committee on "Amendments to the Freight Classification," and committee on "Legislation Concerning Theft of Current," Mr. Jas. I. Ayer, chairman.

Thursday afternoon—Discussion of topic, "Freight Rates on Electrical Apparatus." Report of committee on finance, Mr. John A. Seely, chairman. Executive session. Election of officers.

NOTES.

Electrical Burns.—The remedy used in the remarkable case of electrical burn, reported in these columns last month, may be obtained from G. F. Harvey & Company, Saratoga Springs, N. Y., the preparation being known as "vitogen." We make this announcement in view of the value of the preparation to those subject to electrical accidents.

A Worthy Object.—The Paul Quinn College, of Waco, Tex., is about to institute an electrical course of instruction, and appeals to the electrical industry for contributions to an electrical laboratory. The Paul Quinn College is a negro institute which ranks only second to that at Tuskegee, Ala., which Mr. Brooker T. Washington has caused to be so widely known. Electrical apparatus suitable for experimental demonstration is particularly desired by Prof. William H. Dammond, Professor of Mathematics, who at present is in charge of the organization of the course.

St. Anthony Falls Water Power Plant.—In the article on the St. Anthony Falls water power plant in the May issue, it is stated that the water wheels operating the two 100-k.w. exciters were built by the D. S. Morgan Water Wheel Company, of Dayton, Ohio. This is an error, the wheels having been supplied by the S. Morgan Smith Company, of York, Pa.

Questions and Answers.—That the examination papers of beginners in electrical science should contain an occasional amusing blunder is not surprising, in view of the fact that the new student most probably shares the general opinion that electricity is a mysterious thing, and is therefore apt to be off his guard logically. As several specimens of such answers we quote the following: Question.—What is the temperature coefficient of resistance? Answer.—a = temperature coefficient = number of degrees of resistance per square centimeter. Question.—What do we mean when we say "A charge of electricity?" Answer.—A charge of electricity is an indefinite something, having various properties which are measured in different ways. Question.—A 110-volt dynamo is connected to a circuit. The ammeter in this circuit reads zero. What is the condition of the circuit? Answer. $C = \frac{E}{R}$, $o = \frac{120}{\infty}$ The resistance is minus infinity; i. e., the dynamo is on a dead short circuit, which is a circuit without resistance.

Electricity in Germany.—At the April meeting of the Societe Internationale des Electriciens, M. J. Laffargue read a paper giving statistics concerning the central stations and electric railways of Germany. There are 265 central stations of a total capacity of 67,900 k.w, of which 204 are continuous current, 26 alternating current, 16 polyphase currents, 14 polyphase and continuous current, and 5 alternating and continuous current. On Sept. 1, 1897, there were 96 cities having a total length of 1530 miles of electric railway track, and electrical capacity of 21,465 k.w. Some statistics are given concerning the cost of lighting current. At Frankfort the entire cost, including interest and depreciation, is 6 cents per k.w.-hour. At Cologne and Dusseldorf the cost is 3.85 and 2.52 cents respectively, not comprising interest and depreciation. The consumption of fuel is about 6.6 per k.w.-hour, coal costing from $2.40 to $3.60 per ton. The charge for electrical energy varies from 16 to 20 cents per k.w.-hour for lighting, and from 5 to 6 cents for power, with discounts for quantity, which in some cases range as high as 50 per cent.

Telegraph Tournament.—The Morse National Telegraph Tournament, which was held at the New York Electrical Exhibition May 14, was excellently conducted by Mr. Fred. Catlin, manager; Mr. T. J. Smith, master of ceremonies, and Mr. A. E. Sink, timer, not a hitch occurring in the programme. The prizes amounted to $1350, of which the Western Union Telegraph Company and Postal Telegraph Company each contributed $250. The championship sending contest was won by Mr. W. M. Gibson, who sent 254 words in five minutes with but one error, Mr. F. L. Catlin winning the second prize on 253½ words with one error. Both cases broke all previous records, which had been 248 words, or 252 words including a record not generally recognized on account of its imperfect Morse. In the code sending class the first prize was won by Mr. G. W. Conkling (345 words in five minutes), and the second prize by Mr. W. M. Gibson (330 words), the former breaking previous records. In the ladies' sending class Miss J. McManus and Miss Emma R. Vanselow won the prizes, the former on 239 words with eight errors (superior Morse), and the latter with 241 words and eight errors (good Morse). In the 230-word sending class, the prizes were won by Mr. Charles F. Edney (233 words, excellent Morse), and Mr. F. M. McClintic (242 words, good Morse). The prizes in the 240-word class were won by Mr. J. D. Hinnant, 252 words, and F. M. McClintic, 243 words. At this writing the prizes for the typewriting receiving contest have not yet been awarded. Almost one hundred contestants participated in the tournament. Phonetic records in duplicate were made in the championship and code classes, which can not only be reproduced at any time in the future, but multiplied at will.

Heavy Electric Railroading.—At the May meeting of the New York Electrical Society at Madison Square Garden, New York, Prof. S. H. Short read an interesting paper on "Heavy Electric Railroading," in which he gave a review of the development of electric traction up to the present time, and considered the probable future in this field. He noted the general adoption in large cities of the underground conduit system, and predicted a close competition with the overhead trolley in the near future. Taking up the subject of suburban and interurban roads, he illustrated by examples how seriously the latter have affected the traffic of parallel steam roads, even when the latter reduced fares below those of the former, this being commented upon as furnishing the best proof of the advantages of electric traction. Several cases were spoken of in which steam roads have had much financial success in handling local traffic by an electric service. Prof. Short said that the trolley system of Cleveland is the largest in the world, there being no less than six roads from 10 to 40 miles in length, all using heavy cars and running on printed time schedules. As an illustration of the heavy work done, a stereopticon view was given of a heavy excursion train on the Akron, Cleveland & Bedford road, hauled by a four-motor equipment aggregating 200 h.p. As an illustration of the financial possibility of suburban electric roads, he quoted the case of the Chicago Northern & Pacific Railway, which, after a struggle with electric competition, leased its lines to the Suburban Railway of Chicago, after which the entire system was electrically equipped and the lost patronage regained. Prof. Short went into the details of the construction of the third-rail system and explained the main features of the multiple-unit system of control. He made an interesting statement that some 70,000 or 80,000 h.p. will be required to operate the Manhattan Elevated system of New York alone, and as Prof. Short has very carefully worked out the engineering details of elevated roads, his figures have, therefore, considerable significance. Among the views thrown on the screen was one showing the characteristic curves of a No. 15 L Walker motor, the Professor apologizing to the non-technical portion of his audience for the technical nature of the exhibit; the curves, however, were sufficiently remarkable to justify their being shown—representing, as they did, an efficiency attaining 92 per cent. As the motor weighs only 3900 lbs. and has an armature speed of 550 r.p.m., the showing is one of which Prof. Short, the designer of the machine, might well be proud. As to long distance traction, Prof. Short seems to think that the immediate prospects are bright for a system in which the current is transmitted at from 30,000 to 40,000 volts over distances of 50 or even 100 miles, the current being taken from the high-tension feeders at substations from 25 to 30 miles apart and transformed by means of static and rotary converters to the regular railway direct current pressure. He reviewed what has been done in the heaviest kind of electric railway work, referring to that of the General Electric Company on the Baltimore & Ohio belt line. The value of the gearless motors used there was mentioned, and here, as throughout the lecture when referring to pioneer and other work, Prof. Short's modesty forbade him to add that this construction was applied to the Baltimore & Ohio locomotives under his patents.

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Electrical Conventions and Exhibitions.

The present month will witness the ending of the Electrical Exhibition, the conventions of the National Electric Light and the Northwestern Electrical Associations, and the opening of the Trans-Mississippi Exhibition, at which latter Prof. Owens has seen that electricity shall play a leading part. The electrical show has been a decided credit to the industry represented, and though handicapped by unparalleled adverse weather—there were but four favorable evenings during the month of May—the attendance showed that electricity still retains its popularity. The plan of the Northwestern Electrical Association to hold its convention afloat is a decided novelty, the outcome of which will be attended with much interest. If successful it will establish a precedent that may perhaps lead to convention excursions on ocean steamers, for a convention trip to Bermuda in the Winter or to Newfoundland in the Summer would have enticing features.

The programme of papers for the Chicago Convention is a strong one, and particularly so with respect to the interests of large central stations. The papers by Mr. Wagner and Mr. Ferguson give promise of being very important contributions to central station engineering, the writers having had exceptional opportunities in the branches which they will treat. The papers of Mr. Walbank and Mr. Rice are also extremely apropos, dealing as they do with the question of costs, the analysis of which is a matter of the greatest importance in these days of graduated charges for electrical energy. Transformer economy and municipal ownership complete a convention programme, which from its extreme appropriateness, reflects great credit upon those who had charge of its preparation. Of the committee reports, that on a standard candle power of incandescent lamps will be awaited with much interest. Though first taken up by Dr. Bell in 1891, and definitely brought before the American Institute more than two years ago, thus far no progress seems to be made toward the end in view beyond a report of a committee of the latter body, laying down certain principles upon which a commercial standard should be based. It is sincerely to be hoped that action will be taken at Chicago definitely establishing a commercial method of standardization.

Regulating Alternating Current Line Voltage.

On another page will be found an article which explains in a simple manner how, by means of an over-excited synchronous motor or rotary transformer in circuit, the inductive drop of an alternating current line may be neutralized, or both the inductive and ohmic drops neutralized, or even a voltage obtained at any point of a line in excess of the generator voltage. As will be seen, this curious result is produced through the motor or converter being so designed as to take a current leading the impressed e.m.f., thus having an action similar to a condenser. The e.m.f. set up in a condenser acts in a direction opposite to that of an e.m.f. set up in an inductance, and therefore if each of these is of the same value, the one will neutralize the other, which is the condition when the inductive drop alone is neutralized in the case above quoted. If the ohmic drop is also to be neutralized, or if the line immediately beyond the motor or converter is to be compounded, then an inductance or choke coil must necessarily be introduced into the generator side of the line. In this case, while the inductance and capacity may neutralize each other, the voltage between the terminals of the motor or the converter will be higher than that between the far terminals of the inductance and capacity by the amount of the ohmic drop or over-compounding thus provided for. It should be remembered that the neutralization or over-compounding refers to the terminals of the motor or converter; that is, the voltage there is the impressed e.m.f. of the line beyond, which is subject to drop, both ohmic and inductive, as if that were the original source of e.m.f. Consequently, to regulate the voltage of a long line, a number of motors or converters will be required, depending upon the closeness of the regulation desired.

Series and Shunt Machines.

We frequently receive inquiries how to change a series dynamo or motor—usually a small arc dynamo or a railway motor—to a shunt machine. If there is to be no change of voltage, the process is very simple, for it is then merely necessary to substitute a field winding that will give the same ampere-turns as the series field winding at normal load. If the voltage is also to be changed, this will require a change of the armature winding, which, however, may be made at the commutator if the voltage is merely to be halved. Of course, the voltage may be still further reduced by lowering the speed of the machine, but this will also reduce its capacity at the same rate.

For example, suppose it is desired to make a 125-volt shunt machine of an old-style five-light, 250-volt arc dynamo. By counting the series field turns as they are taken off and multiplying by the normal arc current—say 10 amps.—the ampere turns will be determined. But as an arc machine is run with its field over-saturated, an allowance must be made for this, and in the absence of a characteristic curve we may assume that 80 per cent of the former ampere turns will bring us to the right point on the curve of magnetism for the shunt machine. As in this case we would probably not care for a high efficiency, we will assume that about 7 per cent of the current will be used in the shunt, or, say .7 amp. Knowing the ampere-turns, we can now determine the number of turns and from this the length of wire. As the voltage is to be 125 and .7 amp. is to flow in the shunt, its resistance will be 180 ohms. We now have the length of the shunt wire and its resistance, and from a wire table the nearest gage may be selected, which will usually involve some slight change in the current selected.

As the field remains at approximately the same strength, the armature winding must be changed so as to develop only half the original voltage. This may be done by short-circuiting every other commutator bar on its neighbor, disconnecting the ends of the armature conductors and reconnecting, so that the coils in each pair of adjacent slots will be in parallel. Some care will be necessary in doing this, as the operation must be continued in the same order all the way around. If it is desired to compound the machine, the series winding may be determined roughly by running the machine. first on open circuit, then with full load, and noting the drop. The ratio between this drop and the normal voltage, multiplied by the shunt ampere turns, will give the additional ampere-turns required; and this divided by the full-load armature current will give the number of series turns. If the machine is to be over-compounded, add the extra volts to the drop above found and proceed as before. The above is a somewhat rough method, but it is accurate enough for any ordinary practical case. By changing the speed of the machine the voltage, if not exact, may be brought to the desired value. The above method may be used to change a 500-volt railway motor to a 250-volt shunt dynamo or motor.

Our Leading Articles.

The subjects of the leading articles in this, our annual Electric Light Convention or souvenir number, have naturally been selected with especial reference to the department of central station engineering. In making the selection, however, the interests of those connected with the average American central station have been more particularly kept in view. The installations in great centers of population form but a very small percentage of the 2700 or more central stations in this country, and many of the problems there encountered are of such a special character as to have little more than an academic interest for the average central station man.

Among the live topics of the present day are the employment of gas engines and storage batteries in central stations, and the reconstruction of old arc light plants. Each of these will be found treated elsewhere in this issue, and the first two with reference to plants of a size that form the great majority in this country. The article by Prof. Flather describes a gas engine station of moderate capacity, but one in which all of the engineering details have been worked out in a proper manner. As natural gas is found over a large region in the Central States, this article should give food for reflection to those in charge of electric lighting stations situated therein, while others may find it to their advantage to investigate the claims made as to the intrinsic economy of the gas producer and engine over the steam boiler and engine. The electric light station described by Mr. Sage is a type of many hundreds of small stations scattered throughout the country, which, from their nondescript character and small income, would seem to offer little encouragement toward such an innovation as a storage battery would likely be considered in such a quarter. It is, however, most frequently in just such stations as these, where the load line conditions are peculiarly unfavorable, that the storage battery may turn a losing venture into a financial success.

The article by Mr. Herrick on switchboard reconstruction will particularly appeal to the central station man who has begun to realize that an old-time switchboard is nowadays apt to result in doubt being cast upon one's progressiveness. Mr. Herrick shows that any electrician of mechanical skill can reconstruct or replace an old board, and at an expense that is far from appalling to even a close board of directors. Prof. Shepardson, in his article on the 220-volt system, discusses the subject from the dollars and cents point of view, and shows that it cannot be taken for granted that this system has always the advantage over the alternating current system in the case of small towns, as claimed by some of its supporters. Indeed, the two are often so nearly balanced that when a decision is to be made between them, the part of wisdom is to engage a competent engineer to give final judgment.

In no branch of central station engineering has there been a greater change in recent years than in arc lighting, and this is strikingly exemplified in the article on the new Brooklyn arc light plant. Circuits of 6000 volts and units of 250 lights are a great advance, and coupled with this is the driving of centrally located plants by motors supplied with power generated in a station located miles away. There is little doubt but that in the near future the arc plants in all large cities will be similar to the one here described. The article by Mr. Francis Jehl on underground distribution will be found of much interest in showing that on the Continent the cheap and simple method of laying underground on sand in a ditch is now almost universally employed and with excellent results. This practice has commenced to be adopted in this country, and the facts adduced by Mr. Jehl should result in removing any remaining doubts concerning its practicability.

The steam plant is considered in two able articles—one by Mr. Snow on mechanical draft, and another by Prof. Aldrich (now serving as a volunteer Engineer officer in the navy) on the steam engine. These articles bring forward the two most important points of the day in steam practice, and the first mentioned is of particular importance with reference to electrical generating plants. That under all circumstances where the boiler plant is of any size there is economy in mechanical draft is, we believe, no longer denied. In electrical generating plants, however, it presents, owing to the character of the load line, a precious advantage in permitting the rate of combustion to be varied according to the demands of the moment. With mechanical stokers, economizers and induced draft, the steam generating department will be on a par with the other parts of a power plant instead, as in the past, the wofully inefficient and neglected part. Prof. Aldrich agrees with the views expressed by Prof. Durand in these columns a few months ago concerning the advantages of superheated steam, and also holds that to be most beneficial the steam should be initially heated and to a high temperature above that corresponding to saturation. We doubt, however, if most engineers of to-day will agree with the statement that if the steam jacket is to be placed on but one cylinder of a multiple-expansion engine, it should be on the low-pressure cylinder, for in this situation it acts during half of the stroke as a super-heating chamber for the vapor entering the condenser. The benefit to be derived from steam jacketing has always been elusive, and at any rate, now that reheaters are being applied, the steam jacket might be well left off all cylinders.

DESIGNS FOR SMALL MOTORS—V.

ONE-HALF H.P MOTOR, WITH DRUM ARMATURE.

BY CECIL P. POOLE.

For this size of motor three types of field magnet are described, the single-coil Jenny, like those previously described, a bi-polar, one-piece magnet, of the so-called iron-clad type, and a similar form with four poles (Kapp type). The armature core and shaft are the same in each case, excepting the number of slots in the four-pole machine. The machine is a ½-h.p. motor, to operate on a 110-volt constant potential circuit, at a speed of 2000 r.p.m. The single-coil magnet, Figs. 1 and 2, has a round core of commercial wrought iron 2½ ins. in diameter and 11 ins. long over all. The ends are turned tapering, as indicated by the dotted lines, to insure intimate contact with the yokes; the taper is from the full diameter to 1¾ ins. and begins with 2½ins. from each end. The pole-pieces are of cast iron. The arms which support the journal yokes are cast solid with the pole-pieces, and their horizontal thickness tapers from ½ in. at the pole-piece to ¼ in. where the yoke is bolted in place.

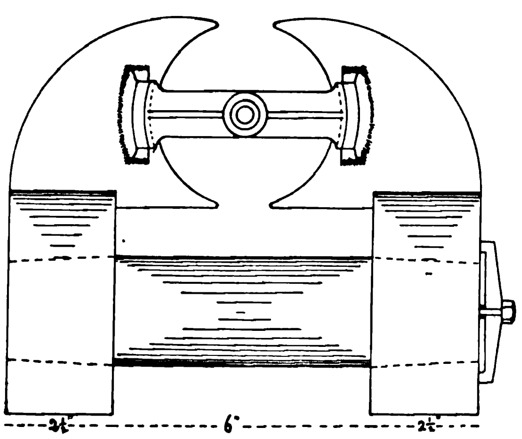

FIG. 1.—SIDE ELEVATION OF SINGLE-COIL FIELD MAGNET.

In fitting the magnet frame together, the best procedure is to bore the tapered holes in the lower part of each pole-piece and turn the ends at the magnet core to the same taper but just a trifle large; then dress each tapered end of the core down very gradually with a fine file (the core being run on a lathe) until the pole-piece can be pushed on by hand far enough to bring the end of the core within 3-64 in. of the surface of the cast iron. The pole-pieces and ends of the core should be punch-marked so as to insure finally mounting each pole-piece on the end which was fitted to it. After dressing down the ends of the core as above described, drill and tap in each end a hole for a ¼-in. machine screw, the purpose of which will be made apparent by a glance at the right hand end of the complete magnet, in Fig. 1, where C is a four-armed claw or spider, with a hole through the centre where the arms intersect. The arms are 3-16 in. thick, measured at right angles to the bolt, and taper from 3-16 to ⅜ in. thick, measured parallel with it. One of these claws or spiders is used at each end of the core, though the drawing shows it at one end only.

After drawing one pole-piece home solid by means of the spider and bolt, slip the other on the other end of the core loosely and clamp the pole-pieces lightly between two iron plates with planed surfaces, applied between the journal arms, so as to keep the four horns of the pole-pieces in alignment; then force the second pole-piece home and clamp the horns hard between the iron plates. The bottom surfaces of the pole-pieces are then to be trued up on a shaper or planer and the iron clamping plates removed from the horns.

The next operation is boring the armature chamber and the seats for the ends of the journal yokes. The bore of the armature chamber is 4 3-16 ins.; the seats for the journal yokes are machined to a 4⅝-in. circle for ¾ in. from the outer ends. These operations must be completed before the original position of the frame on the lathe or boring machine is altered. This completes the machine work on the magnet, with the exception of the holes through the ends of the supporting arms and holes in the bottom surfaces of the pole-pieces for bolting to the base.

The journal yoke must be made of brass or some similar composition. The bar is 3-16 inch thick and 1 inch wide, except near the ends where it flares to correspond with the width of the supporting arms. At each end is a right-angle lug, ⅛ inch thick after machining; these lugs fit the machined seats in the ends of the iron arms, and the yokes should be fitted to these arms before the frame is taken apart to put on the magnet coil. The journal box is 1½ ins. long over all, 3-16 in. of its length projecting on the inside of the yoke bar, and 1⅛ ins. on the outside. As shown by the plan view of the yoke in Fig. 3, there are stiffening webs starting flush near the ends of the yoke and attaining a height of ¾ in. where they join the box; these ribs are ⅛ in. thick. The box is 1 in. in outside diameter and bored out 9-16 in.; the bore is bushed to ⅜ in.

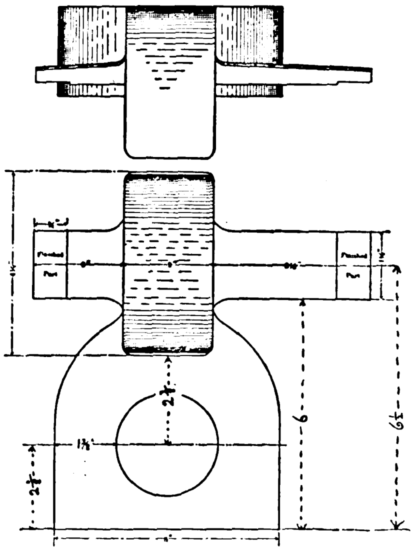

FIG. 2.—ARMATURE DISK FOR FOUR-POLE MACHINE.

No particular form of oiling device is specified as any amateur of sufficient ability to build such a motor will be fully competent to decide this detail for himself. The journal yokes are held in place by ¼-in. cap screws passing through the ends of the supporting arms and tapping into the lugs on the yokes.

The field coil contains thirty-five layers of No. 26 double-cotton-covered magnet wire. After the magnet is fitted as above described, it is taken apart and two circular fiber heads, 4½ ins. in diameter and ⅛ in. thick, are put on the core with a driving fit, care being taken that the distance from outside to outside of the heads corresponds with the space between the perpendicular faces of the pole-pieces when the frame is assembled; this measurement should be taken prior to dismantling the frame. A groove must be cut on the outer face of one head, from the centre to the outer edge, in order to form a channel for leading out the starting ends of the coil when the frame is re-assembled, at which time two disks of oil paper with one of mica between them, must be threaded on the core outside of this head to insulate the leading-out wire from the pole-piece. Before winding the coil insulate the core with a strip of muslin just wide enough to go between the heads and long enough to wrap around the core three times; this should be heavily shellacked before it goes on. If the coil is carefully wound it will be 210 turns in length along the core; the number of turns in this direction is not particularly essential, but as many should be put on as possible without jamming the insulation, in order to reduce the heat loss. The depth of the winding must be 35 layers.

After winding the coil and securing the ends, put one pole-piece on solid and slip the other on loosely. When it begins to bind, bolt the journal yokes to the lugs on the pole-piece first put on, and insert the bolts through the lugs of the one that is loose. Then tighten up the spider bolt at the end of the core and force it into place, the bolts through the lugs serving as guides to keep the pole-piece from twisting on the core. These bolts should be set up little by little with the spider bolt so as to keep the bolt heads within 1-16 in. of the surface of the lugs. As an additional precaution the frame may be set on a true surface and tried at intervals to see if it gets out of alignment; if it does, tap the horn of the loose pole-piece until the bottom surface agrees with the guide. The magnet frame must be provided with a non-magnetic base, preferably composition metal, but allowably of wood.

Figs. 4, 5 and 6 show the shaft and armature core (the latter in cross section), an armature disk, and the shell and head. The disks are of charcoal iron, 4 ins. outside diameter with a 1 in. hole in the centre and an ⅛ in. key-seat, annealed after punching and key-seating; there are eighteen slots ⅜ in. wide and ⅜ in. deep. The shell and one head are cast in one piece (of brass) and consist of a barrel 1 in. outside diameter (when finished), and 2 ins. long, with a head, S, at one end, 3⅛ ins. in diameter and tapered in thickness from ¼ in. near the centre to 1-16 in. at the periphery; at the opposite end of the barrel is a cross-bar, ⅛ in. thick, cast with the barrel, and of the shape shown, being ⅜ in. wide where it joins the barrel and ¾ in. at the center. A ½-in. hole is drilled in the center of this cross-bar and another in the center of the head, S, at the other end of the barrel; the shell is mounted on a mandrel, the barrel is turned down to fit the hole in the armature disks, and both sides of the head are faced off smooth. A ⅛ in. key-seat 3-16 in. deep is cut in the barrel so as to come in the center of one end of the cross-bar, as shown; a ⅛ in. x ¼ in. feather, or parallel key is laid in the key-seat and the disks are threaded on the barrel and compressed against the head by the collar, H, drawn down by two bolts (not shown) passing through the collar and inside the barrel, and tapping into the head at the other end. This collar, H, is of brass, 3⅛ ins. in diameter and tapering from 3-16 to 1-16 in. in thickness when finished. The opening in the center should fit the outline of the cross-bar on the end of the barrel at least closely enough to prevent the collar from shifting under stress of centrifugal force; the collar must be finished up smooth on both sides. A disk of insulation should be put on next to the brass head before the iron disks are put on, and another insulating disk should go between the last iron disk and the clamping collar, H.

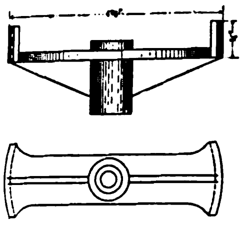

FIG. 3.—JOURNAL YOKE.

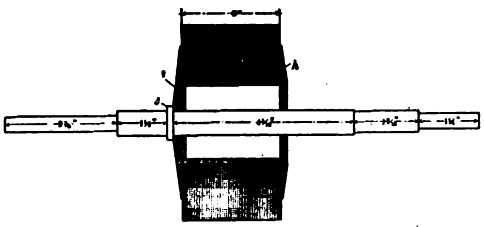

FIG. 4.—ARMATURE CORE AND SHAFT.

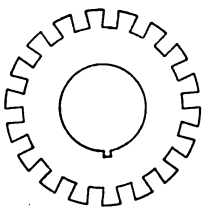

FIG. 5.—ARMATURE DISK FOR BIPOLAR MACHINE.

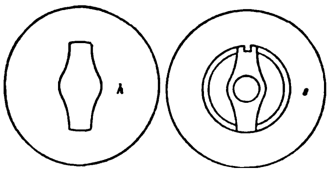

FIG. 6.—ARMATURE SHELL.

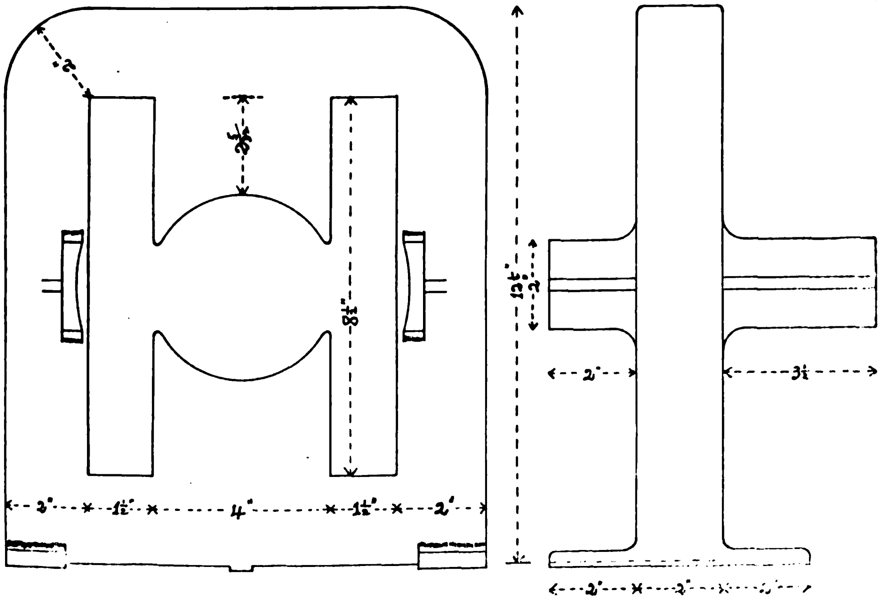

FIG. 7.—END AND PLAN VIEW, SINGLE-COIL MAGNET.

If the slots are cut in the core with a milling machine, the disks must all come off the barrel to have the burrs removed and also be reannealed; the key-seat will insure their returning in the original angular position. It is much better to have disks with the slots punched before the first annealing. The shaft is 10¾ ins. long over all; ½ in. in diameter in the largest part, 7-16 in. where the commutator goes, and ⅝ in. in the journals. A 1-16 in. x ⅛ in. collar, C, is shown back of the armature, the purpose of which is merely to "locate" the armature shell; it is not absolutely necessary, however, and may be left off if desired. The easiest way to provide for it is to make the shaft of ⅝ in. stock, leaving the original metal to form the collar when turning the shell to the proper diameter. The armature shell may be keyed to the shaft or pinned obliquely through the thick part of the head; it must be positively secured by some such means.

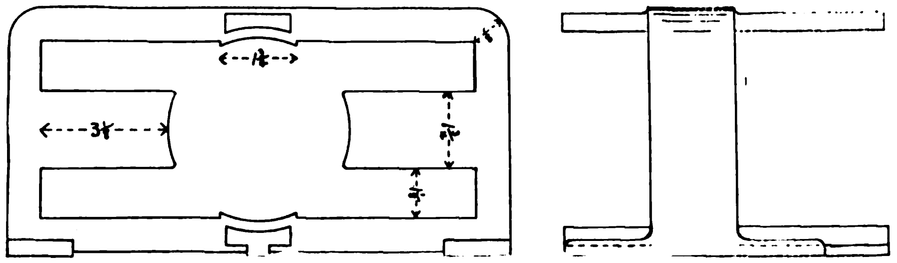

FIG. 8.—FOUR-POLE IRON-CLAD MAGNET.

The commutator shell must be bored to fit the 7-16 in. portion of the shaft, and must not exceed 1¼ ins. along the shaft. The lugs where the wires are attached to the segments may project toward the armature ⅛ in. or so. There must be eighteen segments, and a diameter of 2 ins. is recommended. The quadrant carrying the brush-holders should be fitted to the inner end of the journal box, and carbon brushes (one on each side) not smaller than ¼ in. x ½ in. on the contact surface should be used. If the machine be used as a dynamo (it will maintain about ten 110-volt lamps) metal brushes of the same surface should be used to reduce the resistance of the brush contact. The armature winding is divided into eighteen coils, each having thirty-two turns of No. 20 double-cotton-covered wire, eight turns wide and four turns deep in the slot. The slots must be insulated with troughs of muslin and mica or, preferably, flexible micanite, 0.03 in. thick. The troughs are easily made by cutting the material into strips 2½ ins. long by 1⅛ ins. wide, and slitting the ends so as to permit the projecting portion of the trough to be folded back flat against the core. Before putting in the troughs a disk of heavy drilling, 3¼ ins. in diameter, should be secured to each end of the core by means of varnish, and the outer faces varnished and allowed to nearly dry. Then put in the troughs and put on two more muslin disks, carnishing the whole, and bake until thoroughly dry. Instead of winding each coil in diametrically opposite slots, take slots lacking one of being precisely opposite.

A good plan is to make a sketch of an armature disk and number the slots from left to right successively around the periphery. Then wind the coils as follows, the coil numbers indicating the order in which the coils are put on, not the order in which they are connected to the commutator:

Coil Number.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Starting in Slot Number.	1	10	13	4	7	16	2	11	15	6	14	5	18	9	3	12	8	17
Ending in Slot Number.	9	18	3	12	15	6	10	1	5	14	1	13	8	17	11	2	16	7

Each pair of coils must be covered with muslin where they cross the heads before the next pair is put on, and before coil No. 8 is wound on top of coil No. 1 in slot No. 1, the bottom coil must be insulated by a strip of micanite laid in the slot; this is true of every bottom coil.

After the winding is on, and before connecting up to the commutator the band wires should be put on. Use No. 19 B. W.

G. soft tinned-iron wire, known by hardware dealers as "white stove-pipe wire," for the bands, and put them on under as heavy pressure as possible without endangering the armature shaft. Two bands of eight turns each, ½ in. from each end of the core, will suffice. A strip of mica, between two strips of fuller-board, must go under each band, and the bands should be soldered at intervals, not all the way around. Four tin clips located equidistantly, with a dab of solder at each, will give ample security.

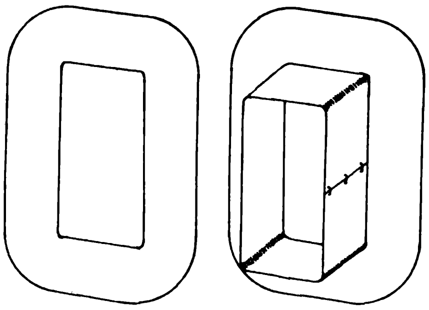

FIG. 9.—MAGNET-COIL BOBBIN.

If cast steel be available, one of the iron-clad types of magnet, shown by Figs. 7 and 8, is somewhat preferable because of the small amount of machine work required. Of these two the four-polar type is considered preferable by the writer, being much lighter in weight and having an "open-head" armature winding. Each of the iron-clad magnets is a single casting; the essential dimensions are shown in the sketches with the exception of the bore of the armature chamber, which is, of course, the same as for the single-coil maget—4 3-16 ins. As the two magnets require the same treatment, varying only in dimensions, the following remarks apply to both:

It will be noticed that the feet of the machine project ⅛ in. below the body and that there is a transverse rib under the center of similar depth. These are to give the machine a floor bearing which may be trued up on a shaper or planer without finishing the whole bottom of the machine. The first operation on the casting is chipping off the numerous fins and lumps with which steel castings are invariably afflicted. An emery wheel may be used for this purpose around the outside of the frame, but in the corners of the coil-spaces a cape chisel and lots of muscular exertion will be required.

Next, the bearing surfaces are trued up, and ½ in. holes drilled in the feet; then the magnet is mounted for boring out the armature chamber and the seats for the journal yokes, all of which must be done with one mounting. This finishes the magnet frame, unless it is desired to put a terminal block on the machine instead of on the base, and do away with the latter. In this event, four ¼-in. holes are to be drilled in the top surface of the frame and tapped for machine screws to hold the block, which may be 2 by 6 ins. and 1½ ins. thick. The journal yoke and journal are the same as shown in Fig. 3, except that for the bi-polar magnet the yoke is 7½ ins. long instead of 4⅝ ins.

The field coils for the bi-polar machine consist of No. 25 double-cotton-covered wire, wound 45 layers deep, and each coil is 80 turns long. The coils are to be wound in fibre bobbins as shown by Fig. 9. The heads of the bobbin must be 2⅛ ins. apart, and the body must be ⅛ in. wider and longer than the magnet core, actual measurement. Before winding the coil, the bobbin must be mounted on a wooden core of proper size to fit the opening through the center and having flanges or heads at each end to "back up" the heads of the bobbin; one of these heads is put on permanently and the other is secured by two screws so as to be removable. A spindle of 1-in. iron goes through the center of the wooden core upon which to mount it in the lathe for winding.

When a coil is completed, bend the wire back upon itself near the end, tie a linen thread in the loop formed and secure the end of the coil by passing the thread several times around the coil and tying its ends together. Then varnish the outside heavily and bake the coil at a low temperature—100 to 125 deg. F.—until the varnish is hard.

The coils for the four-poular machine are 35 layers deep and 110 long, of No. 25 wire. The heads of the winding bobbin are 3 ins. apart. The instructions for winding the coils for the bi-polar iron-clad machine apply to these also. In connecting the coils on the machine, however, there is a difference. On the bi-polar machine the final end of one coil must be connected to the beginning of the other; on the quadri-polar the reverse is true. Fig. 10 shows diagrammatically the manner of connecting the field coils of the quadri-polar machine. It will be noticed that the exciting current passes around the cores in opposite directions.

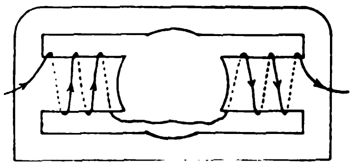

FIG. 10.—BIPOLAR IRON-CLAD MAGNET.

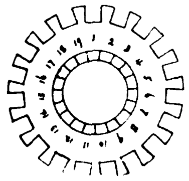

FIG. 11.—ARMATURE DIAGRAM.

The connection for the bi-polar machine is exactly the reverse of that shown.

The armature core of the four-pole machine has 19 slots 3-10 in. wide and ⅜ in. deep, instead of 18 slots ⅜x⅜. There are 19 coils, each having 28 turns of No. 20 wire, 7 turns wide and 4 turns deep. These may be wound directly on the core, but it will probably be easier for an amateur to wind them in a little frame, tie them at intervals with thread, and put them on the core complete. The winding frame will be exactly like the one for the field coils except in size. The "channel" formed between the heads must be 9-32 in. wide and ¼ in. deep. The body of the frame, which determines the length and width of the coil, is 2¼ ins. one way and 2¾ ins. the other. The coils are put on and connected up as indicated by the following table:

Number of coil.	In slots No.	Beginning end goes to segment number.	Final end goes to segment No.
1	1 and 6	1	11
2	2 " 7	2	12
3	3 " 8	3	13
4	4 " 9	4	14
5	5 " 10	5	15
6	11 " 16	11	2
7	12 " 17	12	3
8	13 " 18	13	4
9	13 " 19	14	5
10	15 " 1	15	6
11	16 " 2	16	7
12	17 " 3	17	8
13	18 " 4	18	9
14	19 " 5	19	10
15	6 " 11	6	16
16	7 " 12	7	17
17	8 " 13	8	18
18	9 " 14	9	19
19	10 " 15	10	1

The numbers of the coils indicate the sequence in which they are put on the core, and this order should be observed in order to secure maximum symmetry of the wires across the heads of the core. The numbers of the slots and segments refer to the diagram shown by Fig. 11. Each figure applies to the slot and segment between which it is located.

The brush quadrant for this machine is also different from that of the other two; instead of bearing upon the commutator at diametrically opposite points the brushes must be 90 deg. apart—corresponding with the relative angular positions of magnet poles of different signs. In the bi-polar iron-clad the "north" and "south" poles are, of course, opposite each other; in the four-pole machine the poles directly opposite are of the same sign—if one horizontal pole is "north" the other must also be "north," and the other two, without coils, will be "south."

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ELECTRICAL APPARATUS FOR AMUSEMENT—V.

SPIRIT CHIROGRAPHY.

BY NEVIL MONROE HOPKINS.

During the early periods of civilization those possessed with the faculty of inscribing their thoughts and expressions on parchment were classified among the highly educated. Waiving the modern and liberal meaning of the term, we will have introduced to us, associated with the following experiment, a highly educated spirit, whose manifestations are apparent in a very "marked" degree, although the etherial constitution of the phantom hand prevents an impression of its image on the optic nerve. The necessary simple requirements for the use of this unseen hand consist of a coarse quill pen, flagon of India ink, a school slate and light wooden easel, together with the little swinging cabinet illustrated in Fig. 1. The spirit never protests at a close examination of the pen, ink and paper upon which its writing is dependent, and allows of a close, unobstructed observation of the slate, easel and cabinet, which serve merely to mount the "parchment" and provide a place for the pen and ink, respectively.

Before describing the secret of the spirit hand, the effect of the experiment will be given. Having satisfied the skeptical by freely presenting the writing material for scrutiny, the paper selected is immediately mounted on the slate in full view of the onlookers, by means of small gummed wafers, and the whole placed carefully on the little supporting easel. Attention is called to the little cabinet which is seen swinging from a pair of cords or colored ribbons, which may be swung around in any position in order to show up its construction. The cabinet is sharply rapped inside and out, with the magician's wand. demonstrating wooden construction, and proving the absence of wires, strings and other delicate and complicated contrivances.

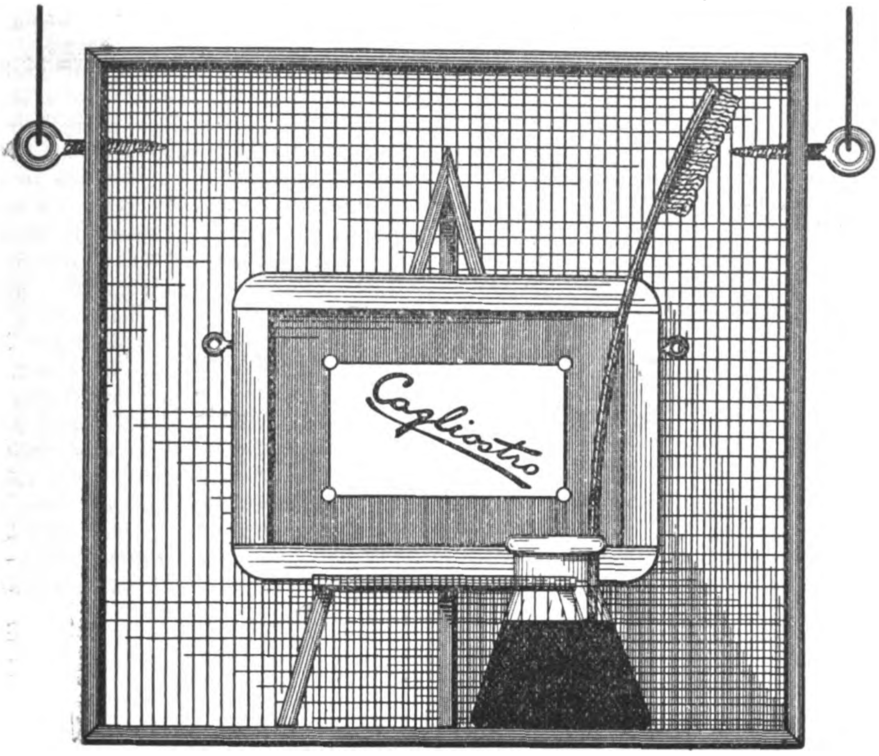

FIG I.—ELECTRIC SLATE AND CABINET.

The easel, slate, ink and pen are now placed inside, and the cabinet is covered with a silk handkerchief or colored scarf Sounds are heard within, and the cabinet is seen to tremble as if a material living thing had entered. When the moving ceases and no more sounds are emitted, the covering is removed, displaying an inscription plainly written across the paper, and the pen, which was previously in the ink, removed from the bottle and lying on the bottom of the cabinet. The paper can be taken from the slate at once and be passed around for inspection, where the writing will be immediately identified as executed with the India ink. Almost any inscription or answers to queries may be produced in connecion with this cabinet if the performer is quick and exercises some little skill and ingenuity. A small bell placed inside may be made ring by the spirit when the writing is complete, or rappings can take place inside in response to questions.

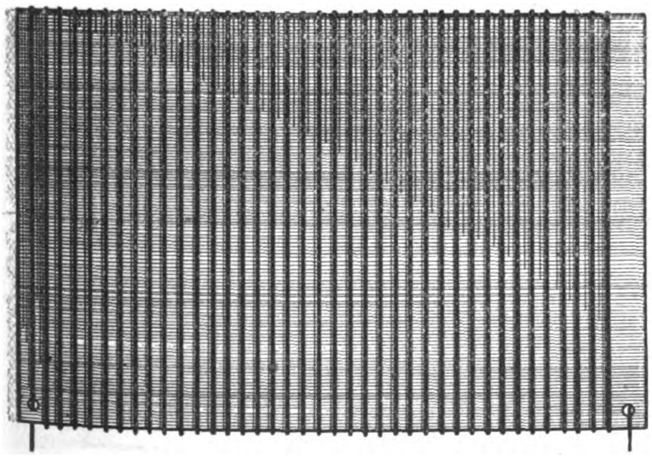

FIG. 2.—HEATING COIL OF ELECTRIC SLATE.

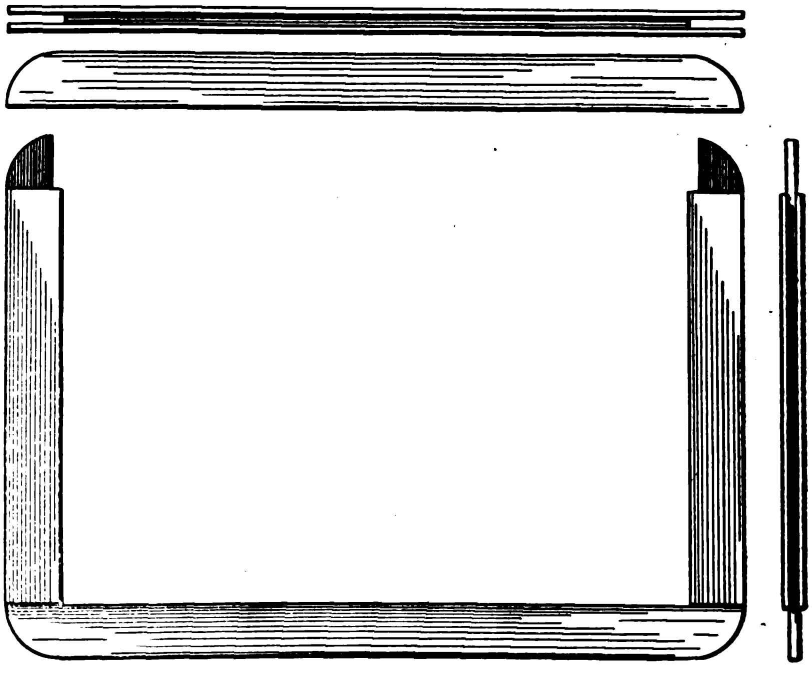

FIG. 3.—FRAME OF ELECTRIC SLATE.

The explanation of these manifestations is as follows: The paper, which may be closely examined, is previously written on with diluted sulphuric acid and allowed to dry thoroughly. Many sheets of paper may be prepared in this way, being secretly marked by pin pricks in order that the performer may know one inscription from the other. By subjecting these sheets of paper to heat the inscription appears in the blackest and most vivid characters, bearing the closest resemblance to dried India ink. The slate and easel, together with the cabinet and the supporting "ribbons," provide the heat through the "medium" of electricity. The pen is drawn from the ink, and the rappings and bell ringings are accomplished by black silk threads.

Different kinds of linen writing paper should be written on with pure acid of varying strengths, until the most perfect results are reached. Linen paper with a slightly rough surface, and a suspicion of yellow in its whiteness, will usually give the best results, it being very difficult to discover any traces of writing when the acid has dried. The acid used should be the purest, the cheaper grades of sulphuric having a yellow tinge. To make the writing fluid, add about fifty drops of the concentrated acid to one ounce of filtered water, and test the writing done with this after drying by holding over a bunsen flame or alcohol lamp, if the electric slate is not made. The blackest characters will appear in a few seconds and be of permanent character.

Let us now take up the construction of the "electric slate" and easel. Fig. 2 represents the slate removed from the frame, being wound with the heating wire. This slate is designed for direct connection with a 110-volt electric lighting service, and will heat up nicely if the directions are carefully carried out. Before winding the slate a small hole is drilled in each of the upper corners, as shown in the figure, to facilitate the putting on and the securing of the wire. An ordinary school slate measures seven by eleven inches, not taking into account the wooden frame. The frame can be taken apart without breaking the corner mortices by applying a strong pressure alternately at two diagonally opposite corners. In this manner the glue used in joining the frame is weakened and parted without injuring the frame.

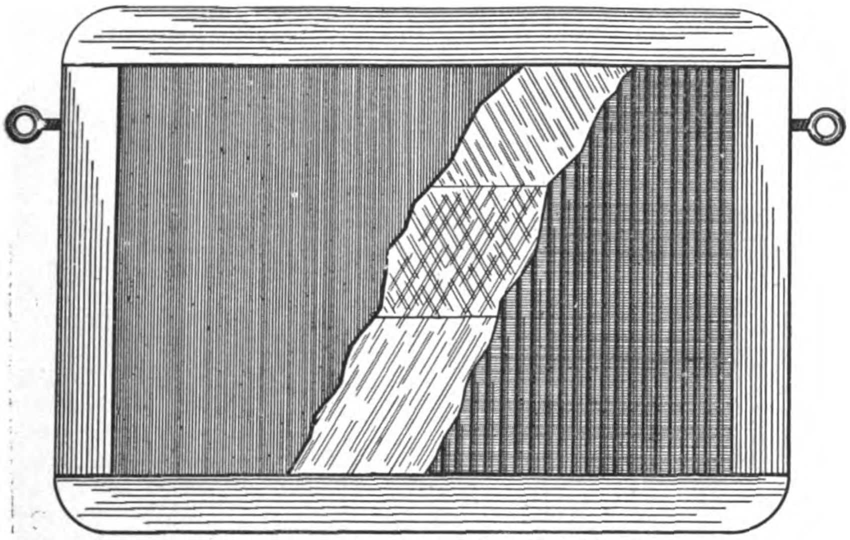

FIG. 4.—CONSTRUCTION OF ELECTRIC SLATE.

The slate is wound with 55 feet of No. 27 tinned iron wire, the different convolutions being put on with a space between of a trifle less than one-quarter inch. If this winding is neatly done the 55 feet of wire will just go on. As the two covers for this slate and winding are made from thin Russia iron, the wire winding must be covered with sheets of mica. Plates of mica are carefully laid on each side of the slate and sheets of mica are bent around the edges just before the iron plates, accurately cut to the proper size, are laid on and temporarily attached by binding with twine.

Great care must be exercised to prevent the ends of this winding from coming in contact with the Russia iron sides, and to prevent this the following precaution is suggested: Where the holes are drilled, insulated copper wire can conveniently be made to join the iron by cutting off a small length of the insulation and wrapping the copper wire about the iron. As copper conducts electricity about seven times as readily as iron, the copper wire will not get very hot, and consequently its insulation will not be injured. The copper wire should be about No. 20, being larger than the iron winding, which gives it an additional factor against heating.

Figure 3 shows the frame of the slate partly taken apart, illustrating the usual construction of the frames. As the slate with its winding, together with its iron sides and mica, is thicker than the width of the groove in the framing, it will be found necessary to widen the groove all around. This can be accomplished by taking the frame to pieces, and after clamping in a vise, by running over it with an adjustable plow or groove cutting plane. Almost any carpenter is ready to do this if the reader does not possess such a plow.

The slate, with its winding, mica covering and iron sides, is illustrated in Fig. 4, with the mica and Russia iron partly cut away. The screw eyes serve as one pair of terminals for the winding, allowing of the suspension of the slate direct to the lighting wires should the performer wish to vary the trick. A four-ampere fuse is sufficient to place in the circuit of this slate and the lighting wires, fusing out quickly without damage to anything should the iron covers of the slate accidentally come in contact with the wire on the slate. As a matter of precaution, even with the most carefully made "electric slate," the writer strongly recommends careful fuse protection. The ends of the winding of the slate can be conveniently brought out through the crack formed at the juncture of the pieces of framing and secured secretly to the screw eyes.

As the slate is primarily designed to stand on an easel, it must have a second set of terminals for the winding near the bottom, where the framing rests on the shelf of the easel. By referring to Fig. 5 the idea will be made clear. By means of a very small gouge plane or chisel a groove is run around the outside of the frame, designed to accommodate a copper wire in order to make contact with a copper stud at the bottom of the frame. This is done on each side as illustrated, the groove being filled with putty after the wire is in place. The little easel is not quite as innocent as it appears, having a wire concealed in each leg and a pair of contact studs on its little shelf. The floor of the cabinet is equipped with little brass or copper plates, for contact with the studs under the feet of the easel, which lead to the large supporting screw eyes of the cabinet.

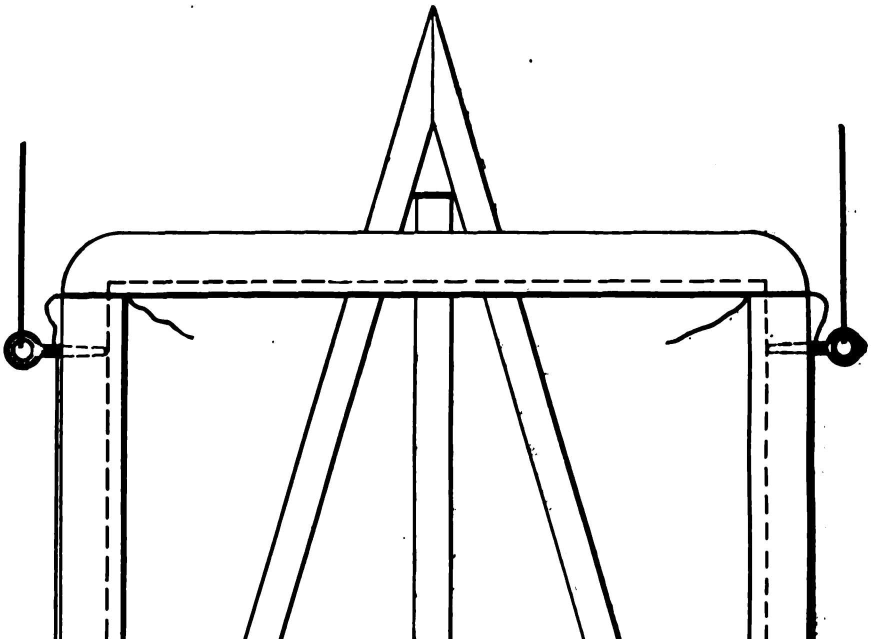

FIG. 5.—ELECTRIC CONNECTIONS OF SLATE AND CABINET.

The ribbons, which are innocent in appearance, possess their own trickery in the form of copper conductors, No. 14 copper wire being sufficient to carry the current economically. This wire had better be of the double cotton covered type, which may be tinted the same shade as the supporting ribbon, and effectually hidden from view if a little care is taken to stitch the wire to the ribbon with silk thread. The Russia iron sides of the slate may be given a slate colored covering of mineral paint to resemble so closely the real thing that detection is very improbable. The slate as described here requires about thirty seconds to get "piping hot" and accomplish the "spirit work." Numerous trials should of course be undergone before exhibiting the trick to an outsider, as the performer would find it awkward to remove the covering scarf with a flourish and find the spirit had not completed the writing. Of course, the ribbons with the secret wires must run to innocent looking hooks above, and the circuit must be equipped with a switch readily reached by an assistant behind "the scenes." The writer wishes to impress, in closing, the importance of neat and, above all, careful work in the matter of insulation and fuse protection, as a voltaic arc within the cabinet would make things too uncomfortable for any well behaved and properly brought up spirit to associate with.

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Central Station Working.

METER TESTING.

BY R. H. STERLING.

In the first portion of this paper, on the testing of meters, two methods of testing were given: one where the meters were run in comparison with a standard meter of the same capacity, and the other by the use of the stop watch. A timing watch that can be purchased for $6 will answer as well as a more expensive article.

While the method of taking the revolutions with a stop watch in calibrating meters may require less current, it is nevertheless a tedious operation with a large number of meters to be tested, but is very accurate and reliable and may be used for calibrating the standard meters, or an occasional meter brought in to ascertain if a customer's complaint is just.

The speed of the meter is directly proportional to the load, and by taking the number of revolutions of the small "telltale" seen revolving on the top of the meter, in a number of seconds equaling the constant for that meter, the number of revolutions noted will correspond to the number of amperes passing through it. The following are the constants for the various Shallenberger meters:

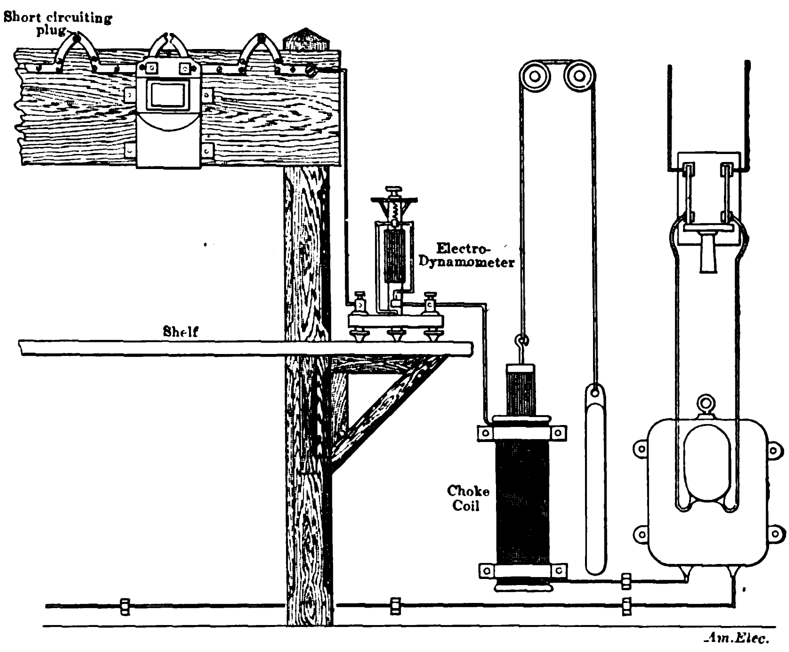
5 Ampere	22.5	80 Ampere	252.1
10 "	33.8	120 "	386
20 "	63.3	160 "	506
40 "	126.6	200 "	623

For example, take a 10-amp. meter, the constant for this being 33.8; if the "telltale" makes three revolutions in 33.8 seconds, 10 amps. are flowing through it; if five revolutions in the same time, 5 amps. are passing through it, and so on. It is, of course, essential that the case should be on the meter at the time of making the test, otherwise the currents of air would cause inaccuracy. A case with a square of glass inserted in the top, so as to observe the index, is necessary for this test.

A positive means must be employed to determine the exact amount of current passing through the meter. This is the first and most essential requisite in meter testing, and calls for a reliable alternating current ampere meter placed in series with the meter being tested. A Siemens electro dynamometer is the best form of instrument in use. It is correct for either direct or alternating current, but is not a portable instrument, and should only be used in the testing room. They are capable of quite a wide range of load, and will be found far better than a switchboard instrument in meter work. It will pay a station to own a reliable instrument of this kind, for all the switchboard ammeters can be checked up by it as well. Careful instructions should be had from the maker for using it, as it is not a direct-reading instrument.

Another useful appliance that is almost indispensable in a testing room is some means to graduate the amount of current to send through the meters. A bank of lamps is frequently used, but fine gradations cannot be had with these, and besides, the current used is wasteful. A reaction or choking coil will be found most serviceable, and the current it consumes is negligible. One to control current from 5 to 40 amps. can be easily made as follows:

A brass tube, 3 ins. inside diameter and 2 ft. long, is split on one side its whole length with a narrow cold chisel or saw to prevent its heating from eddy currents; fiber or lead wood head are placed at each end, and the spool thus formed is wound with four layers of No. 4 B. & S. magnet wire. A core is now required of soft iron wire. Common bare iron wire of about No. 12 gage is cut up into lengths of 2 ft.; enough to make a solid core is formed around a long brass rod with an eye at the end; two fiber or wooden heads threaded on the rod to keep the iron wires in place, the wires being further held in place by wrappings of tape or twine. The core should slide up and down easily inside of the brass tube, and should be counterpoised with a cord and weight. This coil is to be placed in series with the meters and convenient to the standard ampere meter. For controlling heavier currents a somewhat larger coil will be required.



TESTING RACK FOR METERS.

A convenient rack to carry the meters while being tested is very important. It should be a rigid frame, high enough to allow the dials to come on a level with the eyes, and rows of stiff ¼ in. brass studs projecting out about 3 ins. from strips of brass which are screwed to the rack. The object of these studs is to support the meter in a perpendicular position, and at the same time make connection with it to the current—for the studs are placed the same distance apart as are the binding posts of the meter into which they slip, and are fastened by the set screws. The first and last strips in the row are connected to the circuit, and the series of meters completes the circuit.

The accompanying sketch illustrates a convenient arrangement for a testing rack with connections of dynamometer, choke coil and transformer. The details are also shown for the brass strips and studs to support meters on the rack.

These pieces are best cast in brass, and the studs of ¼-in. round brass rod and 3 ins. long, screwed into them. Where they meet at the top a narow space is left and a conical hole drilled in the center, into which is fitted a conical brass plug. This is for completing the circuit should not the full complement of meters be tested at once. A short circuiting switch should also be provided for the dynamometer, for it should not be left in circuit continuously.

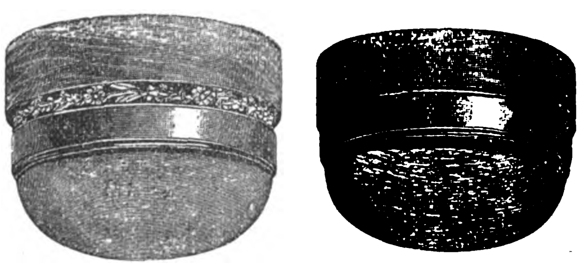
The fact was mentioned previously in

this article that meter cases were not dust or moisture proof; the great importance in this matter seems to be hardly realized by the manufacturers. If they could see a meter brought in with a family of cockroaches enjoying the gear wheels as a merry-go-round, they might deem it necessary to provide some means to exclude such elements; as it is, the station manager has to rely on his own ingenuity in the best manner at hand. The first thing that would naturally suggest itself would be putty—that good old stand-by, but a sticky and unpleasant thing to handle—but if taken in the right manner is no trouble and is very effective. The writer has for some time employed a large tin force gun, something on the order of a battery syringe. The putty must be somewhat softer than it usually comes to force out easily, and the opening at the end made short and not more than ¼ in. in diameter. The putty is placed in the instrument by removing the top and withdrawing the piston.

Now, before the case is placed on the meter a thin even streak of putty is laid on the edge of the back plate by drawing the instrument quickly along while forcing in the piston at the same time. The case can now be placed on and screwed down, and with a cloth any of the putty that may be squeezed out between the edges wiped off. With the later type of meter, which has a cast iron cover over the binding posts, a line of putty should be laid in the crevice between the wooden block and the back plate, for insects can crawl from there down behind the block into the meter. A meter thus treated can defy dust, moisture and all other of its enemies; and with reliable jewels may be safely left to guard the company's revenue for long periods of time without being overhauled. In a large number of meters examined, sealed in this manner and in use for three years, I have yet to find one that needed cleaning, and a far lower percentage of worn jewels discovered, proving that dust and grit have a tendency to shorten their life.

A book should be kept giving a history of each meter under its respective number; the date it was cleaned and tested, and per cent of error; the date installed with consumer's name, and the state of dial when taken from the testing rack. This last is important, for a meter-man frequently forgets to take the reading when he installs the meter, so that when the monthly reading takes place there would be no first reading to make the subtraction with.

Of course, it is important to seal a meter with the lead seal, which in some measure prevents tampering with the instrument, but, unfortunately, the public is becoming educated up to the different means to "beat the meter," and the only safe guard is careful inspection for jumpers on meter loops and small punctures in the tin case, in which is inserted a fine wire to retard the movements. The meter-men should be instructed to be on the lookout for such appliances. The clerk who has charge of the meter books is in the best position to watch for these thefts, for he soon becomes familiar with the average monthly consumption of each consumer, and upon his discovering a sudden falling off in a bill with no good reason, and the standing of the consumer would warrant it, a watch should be kept. When a person undertakes to steal current, he is not discreet and starts in to cut his bill in two the first month. I can recall one instance, a saloon keeper, who paid $10 to a discharged electric light employee for the knowledge of using a jumper. He got so reckless that he never turned his lights off, night or day, and his bill was less than half the usual amount. An observing meterman discovered this and looked for the trouble and found it. Now that different States are enacting laws to protect companies from the theft of current, this practice will be somewhat abated.


FIGS. 1 AND 2.—CEILING FIXTURES.

There is one more subject before closing that is worthy of discussion, and that is, the complaints of consumers regarding their meter bills. These complaints are more prevalent during winter when bills are naturally higher. The man whose self and family were away for an entire month and whose bill was as large as ever, is sometimes a difficult question to deal with. If he will admit he left a servant in the house, that explains it, for the average "hired girl" is a timid thing, and is apt to turn on a full blaze of light to scare away burglars. The cellar light with switch at the head of the stairs is a source of big bills in residences, for it is hard to remember to turn it off on coming up stairs when the light itself is not in view. It is best to listen to all complaints patiently, even to the most angry customer. "A soft answer turneth away wrath"—let him have his say, but stoutly maintain your meter is correct, for it is a sign of weakness to too quickly give in and offer to have the meter tested and is often a poor policy, since you well know nothing can change a meter to make it run faster than it should, being, on the contrary, only liable to change in the customer's favor. When he says he knows to a cent what his bill should be, for he has kept track, etc., there is where you have him, nine times out of ten, for give him paper and pencil and ask him to kindly put down the number of hours he has burned each lamp for the month. On footing up the lamp hours, you will discover he has over-reached, or come very near the amount of the bill. This is a trying time for both, for he cannot go back on his figures. Do not crow over him, for then he will become hot, but smooth him over and you have a friend in him evermore.

NAVAL MARINE ELECTRIC LIGHTING.

BY E. W. COUNTISS.

APPARATUS AND CIRCUIT FITTINGS.

In the preceding article the design and running of circuits was considered, and some of the more special fixtures described. To return to the drilling, we must take into consideration the structural work of the ship. Where a number of feeders and mains are carried along on the same deck, each wire having a hole, and every hole being from ¾ in. to 1⅝ ins. in diameter, it will be seen that considerable metal is to be taken out of the beams, weakening them to a very appreciable extent. To remedy this as far as possible, the plan of allowing the web between holes of the same circuit to be of the same thickness as the diameter of the hole, has been instituted, and the circuits spread apart some distance from each other, the further the better.

In securing the backing in place, holes are never drilled in the deck plate, and wood-screws run into the deck plank above it. Should this be done, as soon as the deck leaks, the water will find its way to that hole, and a dirty, rusty streak will show across the molding, even if nothing more serious occurs. This is the reason the government specifies machine screws for this purpose; and all screws must be brass, no iron ones being allowed, except in the water bottoms, where chemical action would be set up between two different metals by the salt water.

The point to be secured is the greatest amount of illumination with the least number of lamps, thereby reducing the number of parts, and also the weight of the installation. Some idea of the weight of one of these plants may be had from the statement that the 300-light plant on the U. S. S. "Raleigh" weighed 18 tons of 2240 lbs. exclusive of foundations, steam, exhaust and drain pipes, and sundry other fittings, while the plant of the U. S. S. "Texas," with 583 lights, weighed about 40 tons. It will be seen that by the time a plant is completed, there is quite a weight added to the ship, in spite of the fact that every article and appliance is reduced to a minimum weight. The fewer the parts the less complex it is, and the less care it takes to keep in order.

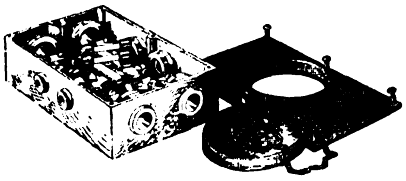


FIG. 3.—BRANCH JUNCTION BOX.

Proceeding to place the fixtures and other wiring appliances, we will start in the cabin. Over the table is placed a ceiling fixture like that of Fig. 1 or Fig. 2. If the table extends both ways equally from the center when drawn out for state occasions, one light would be placed over the center and another at or near each end. If the center of the table happens to be in the center between two beams, little trouble is experienced in locating the fixtures, but if the center should be on the bottom of a beam, the method is to build out on both sides of the beam with a shapely block and secure the fixture to it; and the other fixtures in the same way.

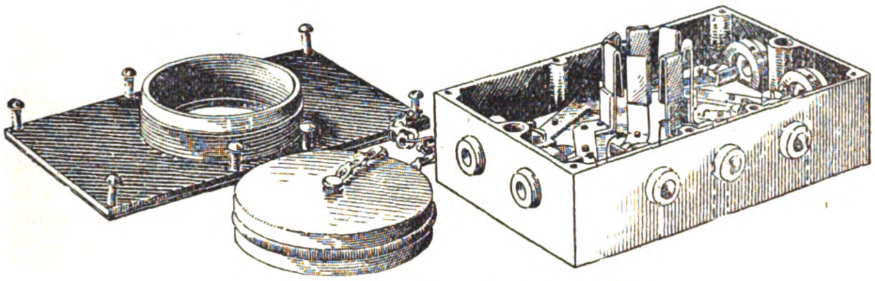


FIG. 4.—WATER-TIGHT ATTACHING PLUG.

The sideboard next is in order, and in the center of the crown piece is usually a single light bracket, or possibly a double ram's-horn bracket. If no conveniences are available for this purpose, and none can be made to suit, then a ceiling fixture like those in Figs. 1 or 2 is installed on the deck in front of it, using the same style fixtures throughout. Over the transom is placed one, two or three one-light brackets, so that a person sitting or lying down may have light for reading.

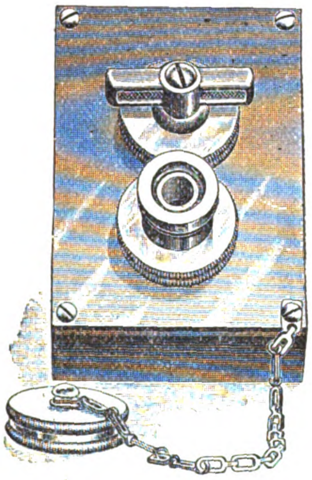


FIG. 5.—WATER TIGHT SWITCH AND RECEPTACLE.

Provision must also be made for the portable desk light, as well as for the ventilating fan. So over the table on a branch circuit are cut in two ordinary keyless receptacles. These have no switches, as the desk light has a key socket and the fan a starting switch. Into this receptacle is screwed a non-water tight attaching plug made of hard rubber, to which is attached the double-conductor silk portable wire at one end, with the fan or light at the other. Fifteen feet is the length allowed for this cord. In the stateroom are located two more of the same style of receptacles for the same uses as in the cabin. The bath room has a ceiling fixture to correspond with the rest of the suite. In the office is installed duplicates of the stateroom fittings.

The ward room is fitted in the same manner, the number of the lights varying according to the size of the space to be lighted. The ward-room staterooms are each provided with non-water tight attaching plugs and receptacles for fan and desk light.

Solder joints are prohibited, and a junction box (Fig. 3) is inserted in the mains, either single or double, as occasion requires, and specifications permit. Where the wires enter the ends of these boxes the spaces are filled up with a soft rubber coned gasket and stuffing nut, the wire and gasket both being treated to a liberal coat of P. & B. paint or its equivalent, after the braid has been removed from the end of the wire and the strands well soldered together. The branch wires enter and leave the sides in the same manner, and with the same precautions taken. All lights are taken from the mains in the same manner, each one having a double-pole fuse protection.

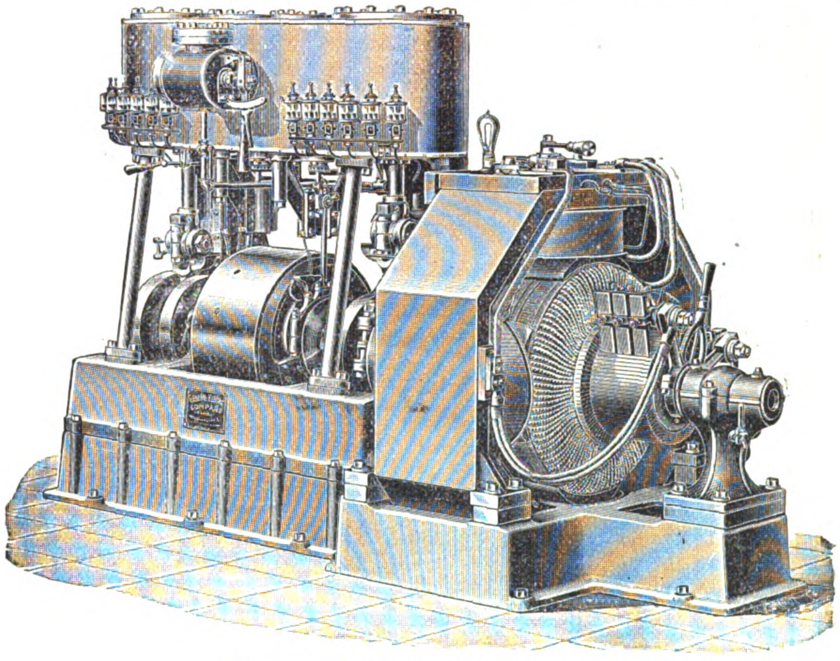


FIG. 7.—NAVAL TYPE GENERATING SET.

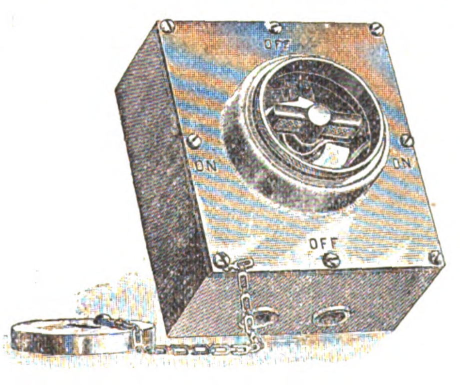


FIG. 6.—WATER-TIGHT SWITCH.

To prevent any accidents through lights going out at inopportune times, such places as on the bridge and magazines are provided with double outlets. Each side light and the masthead and towing lights are provided with two sockets and two lamps, which are attached to lengths of heavy portable wire, with a water-tight-at- places as on the bridge and magazines are taching plug (Fig. 4). Where the water-tight receptacles (Fig. 5) are drawn off from the mains, each one has its own junction box; so that in case one fuse or one lamp fails, the other is still in working order.

The same arrangement is carried out in lighting the magazines and shell rooms. except that the magazine lanterns are placed in light boxes fitted with heavy glass bull's-eye lenses, instead of the light being in the magazine. These lanterns are still further supplied with a candlestick, so that in case the plant is totally disabled during battle, the men in the magazines may still be able to serve out ammunition. The water-tight combination switch and receptacles are placed inside the light boxes so that the lids may be closed down over them to prevent accidents to persons passing by.

In some instances large narrow spaces take the place of these light boxes, being built between the magazines, as in the "Texas," which had two of these, each of which lighted up five magazines. A sub-main was taken off the principal main by means of a feeder box, with a switch (Fig. 6) to control the lights. In front of each bull's-eye, two steam-tight globe fixtures were installed, each having its own junction box. This was the electrical outfit. In addition, a magazine candle lantern was hung permanently behind them.

The mast-head light must have a circuit

running up the mast, with a switch at or near the deck, and two water-tight receptacles near the light, which plug into the receptacles by means of water tight plugs and heavy cords.

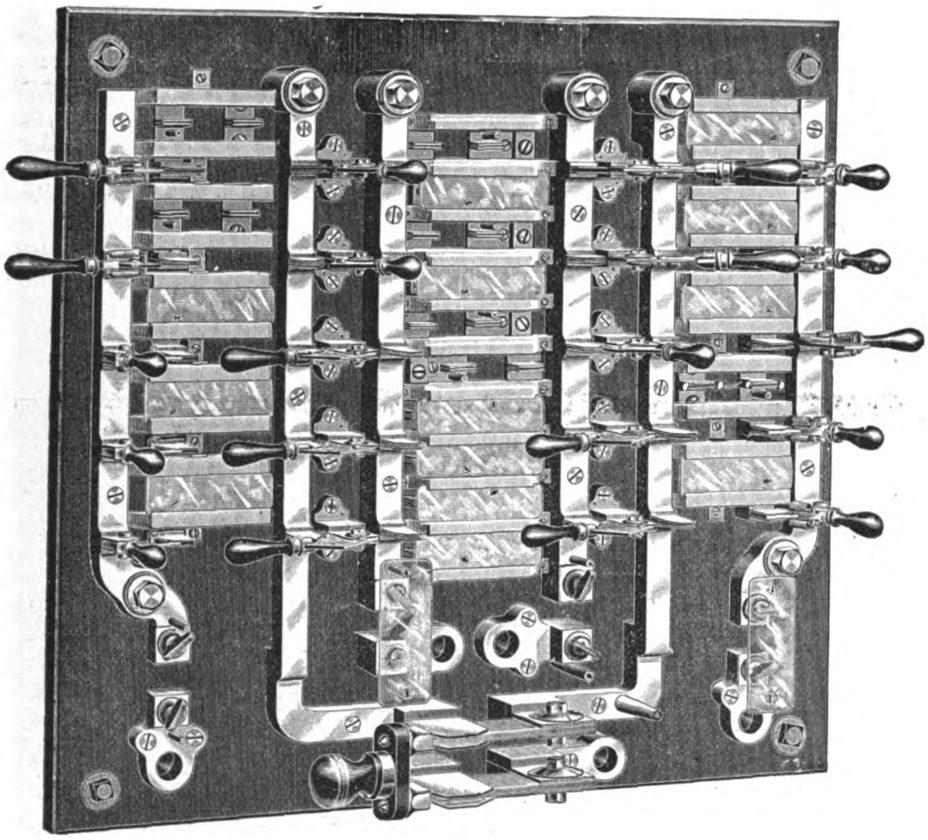


FIG. 8.—STANDARD SWITCHBOARD—2 GENERATORS.

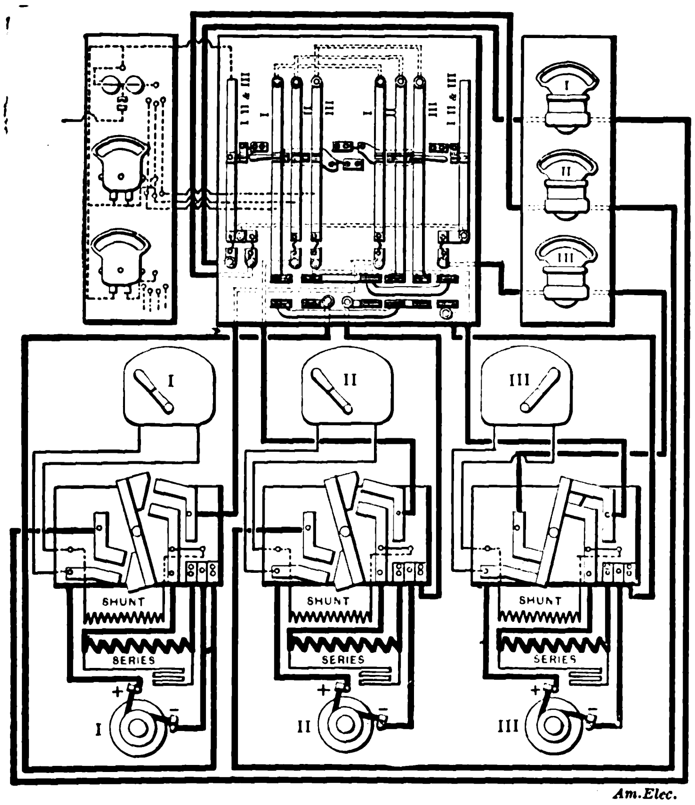


FIG. 9.—CONNECTIONS OF STANDARD SWITCHBOARD—3 GENERATORS.

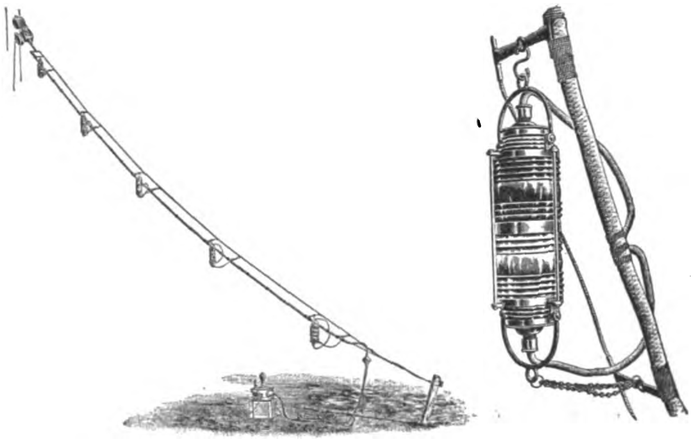


FIG. 10.—ARDOIS SIGNAL HOIST.

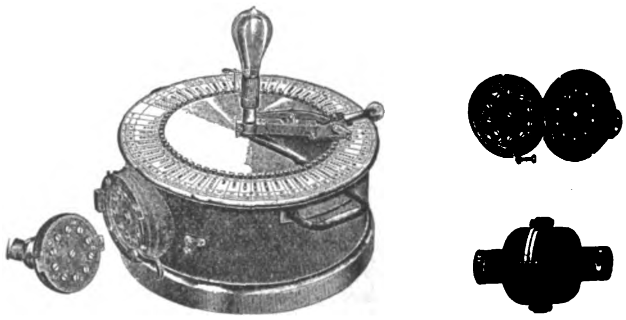


FIG. 11.—ARDOIS KEYBOARD AND COUPLING.

The truck-lights are double lanterns fixed to the top of the mast by a stationary cap, into which the lantern proper screws. The upper or red half is separated by a diaphragm from the lower or white half. Each half has a 32-c.p. lamp, to which current is fed by means of portable wire through pulsating switches located on the bridge. Either half can be caused to burn at will, according to the signal to be transmitted.

The engines and dynamos (Fig. 7) are direct-connected, bolted to a common bed plate, and rigidly secured to the foundations. Each engine is fitted with thrust collars, oil guards and pipes, and so built that the different parts may be easily reached for examination and repair. All nuts have suitable locking devices to prevent them from working loose.

The engines are of the inverted vertical type working with a steam pressure of 100 lbs. per square inch if compound, or 80 lbs. if simple, with a vacuum of 25 ins. they must also be able to work with a variation of 20 lbs. above and below these figures. A variation of not more than 2 per cent in speed is allowed by specification between full load and 20 per cent of full load, when the steam pressure is constant; and the extreme allowance in revolutions is 5 per cent when the variations of steam and load are within the limits, and between full load and no load.

The generators are of the multipolar direct-current compound type, so designed that the magnetic field is inappreciable at a distance of 15 ft. The field frame is divided horizontally through the center of the shaft so that the upper half may be quickly removed. The normal voltage is 80, and the compounding must be such that at the regular speed of the engine the characteristic curve shall show not over 1½ volts from 80 volts from full load to no load. They must be capable of operating in parallel. The armature must be thoroughly ventilated, well balanced and run true, precautions being taken to prevent oil running along the shaft to the windings.

The dynamo must also stand an overload

of 33 per cent for a continuous run of two hours. Both engine and dynamo must be capable of standing this strain for this period without injury to either, mechanically or electrically. The insulation resistance of generators must be one megohm, pressure not being over 1000 volts.

The switchboard, as shown in Fig. 8 is for two dynamos, and the wiring diagram of Fig. 9 is for three dynamos. They are so designed that one or more dynamos may be run singly or together, each circuit being fed at will from either dynamo, or both; or, if three are installed, from all three. It is one of the most compact boards ever used. The center panel shown is placed between two instrument boards, one on each side. The one to the right has on it the ammeters and the one on the left the voltmeters and ground detector.

The three panels are of dark slate, free from minerals, and set in a heavy hard wood frame, the whole being supported by a rigid iron framework or heavy brackets, with sufficient space behind to allow of inspection and repairs.

The Ardois signal hoist (Fig. 10) is composed of four double lanterns, similar in general construction to the truck lights. Each half of each lantern has a wire leading to the keyboard. A general return wire forming the heart of the cable is also connected to each half lantern. The keyboard shows the combination of the lanterns, of which combinations there are 30, each having its own key. Either half of the lantern may be made to burn at will, but both halves of the same lantern never does when the set is in complete order.

For signaling, the Boughton telephotos sytem has also recently been tried experimentally. This consists in the use of four double lanterns similar in general construction to the Ardois light. The lower portion of the lanterns is surrounded by a red lens inclosing four lamps; and the upper portion by a white lens inclosing three lamps, the lesser number being used above in order to equalize the intensity of the red and white rays. Four of these lanterns are placed on wire cables as shown in Fig. 10, each half of these lanterns has a wire leading to a keyboard, a general return wire forming the heart of the cable. By means of the keyboard, combinations of the lanterns may be made by which signals are transmitted. Either half of the lantern may be made to burn at will, and both halves are never illuminated at the same time.

The binnacles, engine, telegraph and rudder telegraphs are also lighted electrically, of which more will be said later on.

The searchlights (Fig. 12) are of the horizontal carbon type of lamps, with both hand and automatic feed. The positive leg of the light has an adjustable resistance inserted in it, so that the current can be varied at will. The standard sizes are 18 ins., 24 ins. and 30 ins. for the projectors, the size given being the diameter of the reflecting mirror at the back of the arc. The turntable upon which the drum is mounted is connected for turning freely in either direction, by means of gearing, and by throwing out the clutches it can be moved about freely by hand. The drum itself is mounted and swung on trunnions, and is controlled in the same way as the turntable, with similar gearing and clutches.

In Fig. 12 the various parts are lettered as follows: A, hand star for slow vertical movement; B, wheel for nut clutch, used for connecting or disconnecting the drum from base mechanism; C, wheel for slow horizontal movement; D, hand star nut for fastening turntable to center pin; E, wooden handles to move the drum by hand; F, clutch for preventing hand star A from moving when electrical control is used; G, controller switch; H, controller handle; K, focusing screw; L, tube in which crank handled socket wrench is inserted to move the carbon carriers by hand; M, door used when carbons are to be adjusted or changed; N, doors used for the changing of the carbons or the cleaningof front door and mirror; O and F, peep-sight holes; R, sliding case, to be opened

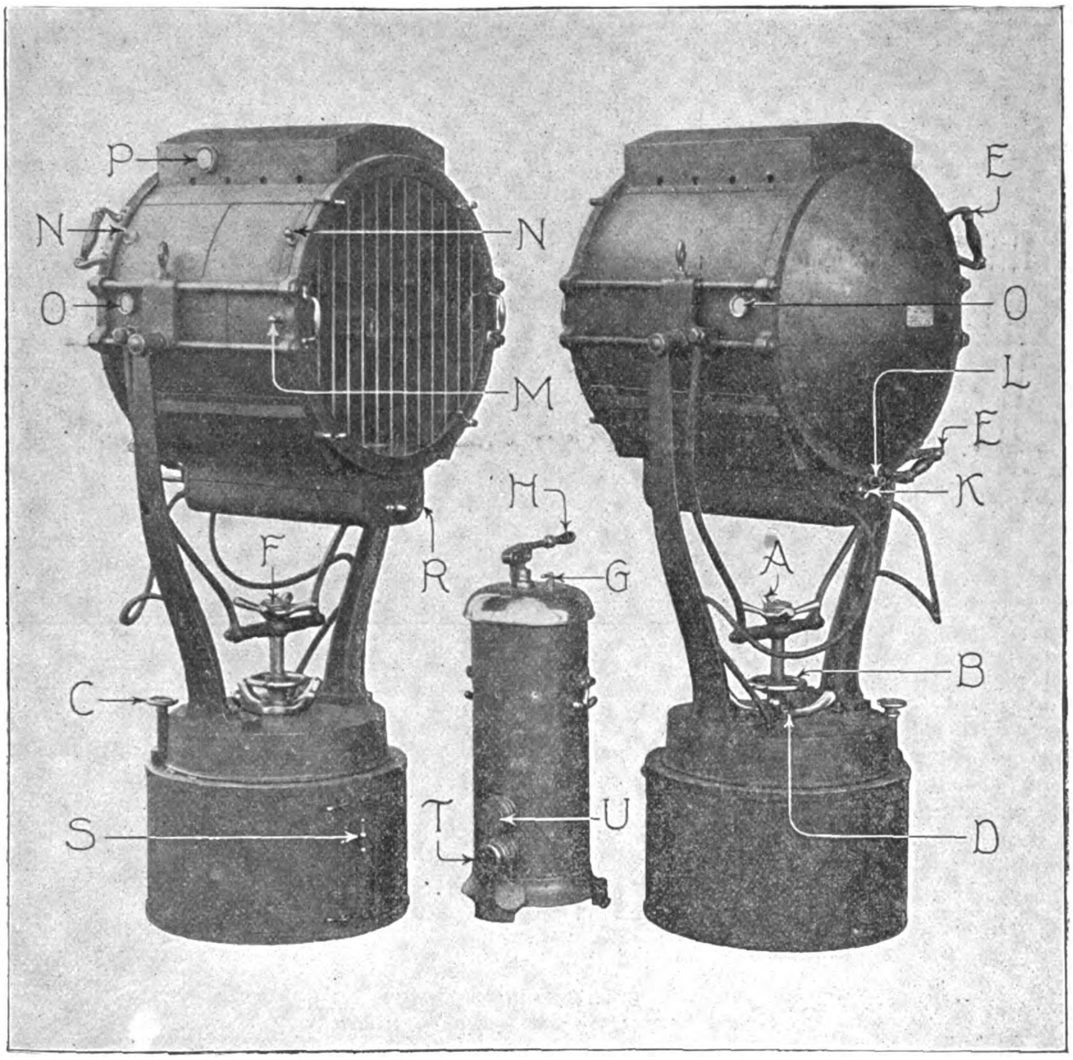


FIG. 12.—SEARCHLIGHT, RECEPTACLE AND CONTROLLER.

when lamp mechanism is to be inspected; S, lamp main switch; T, contact box for controller cable; U, controller fuse.

The electrically controlled projector has a cable connecting it to the controller, which can be placed at a distance and the operator may direct the beam of light where needed. Two shunt motors are contained in the base of the projector, one for training and the other for elevating and depressing. The connecting cables between the projector and controller is so arranged that by depressing the handle on the controller the beam of light is depressed; by raising it, the beam is elevated; turning to the right or left, the beam follows the handle.

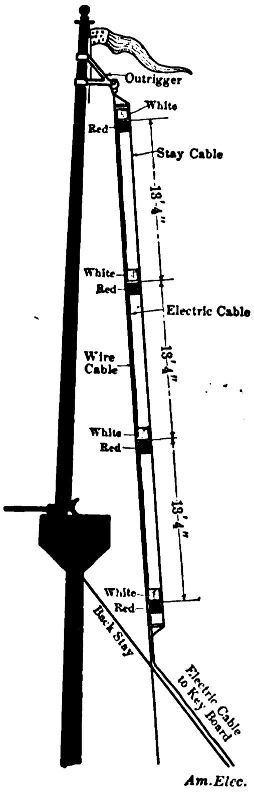


FIG. 13.—TELEPHOTOS SIGNAL HOIST.

If the handle is both pulled up and carried to the right, the beam follows the handle, which is capable of transmitting a double motion to the lamp. The speed of the motors is governed by the distance the handle is moved, and their motion can be checked instantly by releasing the handle of the controller, which immediately flies back to zero.

FIG. 15.—DESK FIXTURE.

These lights will burn six hours with one trimming, and an 18-in. light will render plainly discernible a light colored object 10 ft. x 20 ft. at a distance of 2¼ miles; the 24-in. light at a distance of 3 miles, and the 30-in. light at a distance of 3½ miles.

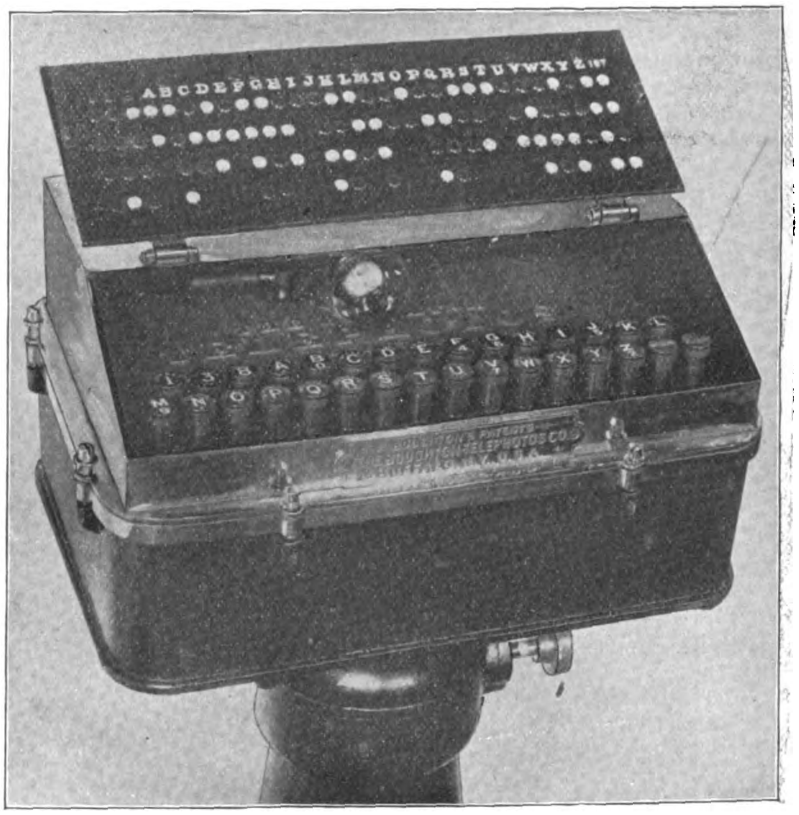


FIG. 14.—TELEPHOTOS SIGNAL KEY BOARD.

The 18-in. light is most economical and gives the best results at from 30 to 35 amps.; the 24-in. at from 50 to 60 amps., and the 30-in. at from 75 to 90 amps., with voltage at 35, 55 and 75 respectively. An 18-in. light recently installed, during a test burned for 6½ hours at 35 volts and 35 amps., without a flicker, so positive and close was the feeding mechanism as controlled by the automatic feed gearing.

Another very important appliance is the electric whistle operator and controller, shown in Fig. 17, which can be applied to any ordinary steam whistle by removing the bell and whistle valve, securing the magnets and valves to the top of the whistle pipe, and screwing the bell on top of the magnets. The utility of this valve control is such as to commend itself the first time a heavy fog settles down about a ship. By means of proper connections between the clock-work control (Fig. 18), in the case, which is installed in the chart house, a blast of 8 seconds' duration is made once each minute, without any attention other than to turn the handle of the switch to the extreme left (Fig. 20), when the spring catch will hold it, until released by hand.

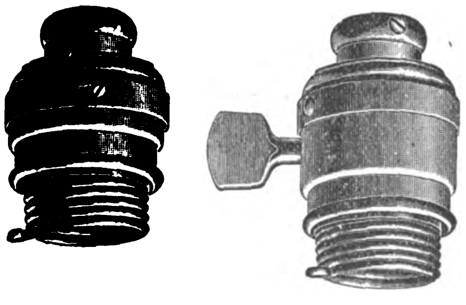


FIG. 16.—LAMP SOCKETS.

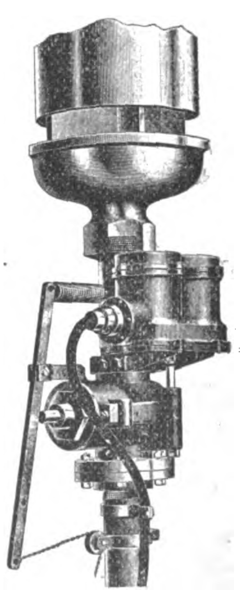


FIG. 17.—ELECTRIC WHISTLE.

When the area of the bridge is such as to make it necessary, several of the whistle valves may be installed, and the whistle operated from any one of them. When the lever (Fig. 20) is turned in such a position that it stands at right angles to the base upon which it is mounted, the current flows through the switch contacts to the valve magnets, which opens the valves, allowing the steam to escape and blow the whistle. On the lid of the clock case is a telegraph key, which, by being depressed, will also blow the whistle.

Current is taken from one of the continual service circuits, by means of a junction box, with a double pole water-tight switch in the circuit.

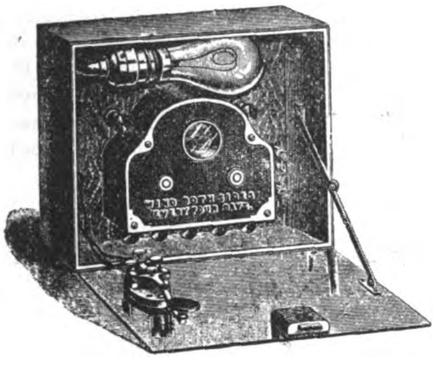


FIG. 18.—ELECTRIC WHISTLE OPERATING CASE.

Single conductor No. 14 B. & S. wire is run between the mains and the clock case to the terminals marked + and —, Fig. 19. A triple conductor wire is run between the operating switch (Fig. 20) to the clock case and connected to terminals 3, 4 and 5. A double conductor is run between the whistle and terminals 6 and 7 on the clock case. This completes the wiring. The fuses are 2 amps.

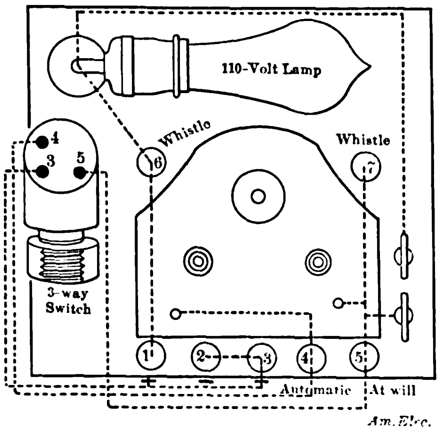


FIG. 19—DIAGRAM OF WHISTLE CIRCUITS.

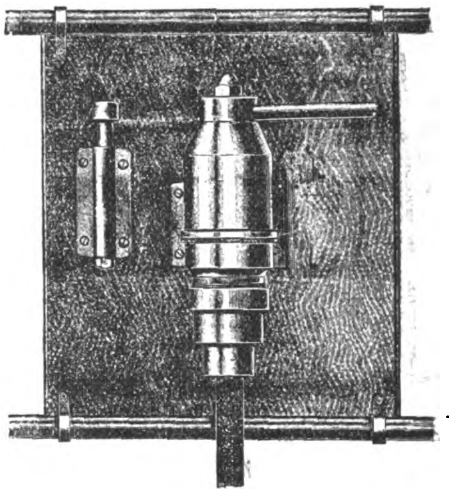


FIG. 20.—OPERATING SWITCH FOR WHISTLE.

◆

INTERIOR WIRING.

BY CHARLES E. KNOX.

CONTROL OF LIGHTS.

So far we have made no particular reference to the control of the lights. This must necessarily be considered now, as it enters very materially in laying out the branch circuit wiring.

In these *fin de siècle* days things formerly considered luxuries are now accepted as ordinary necessities. In the early days of interior wiring local switches for controlling the lights were rarely used. Sometimes a switch was placed at the distributing center for controlling all the lights fed from that point, but even this was infrequently done. Sockets with keys were generally used, and the lamps turned off individually by these keys.

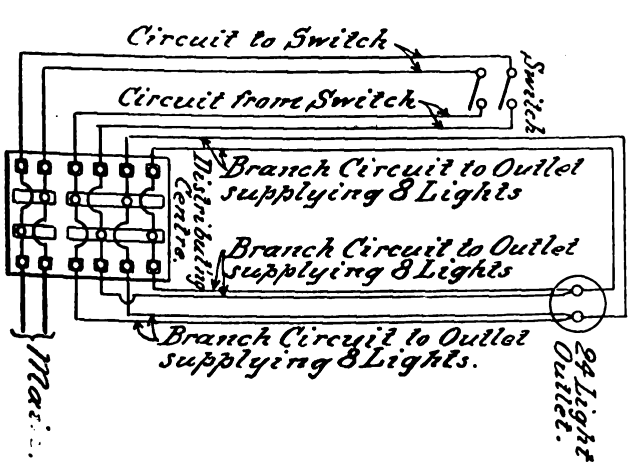
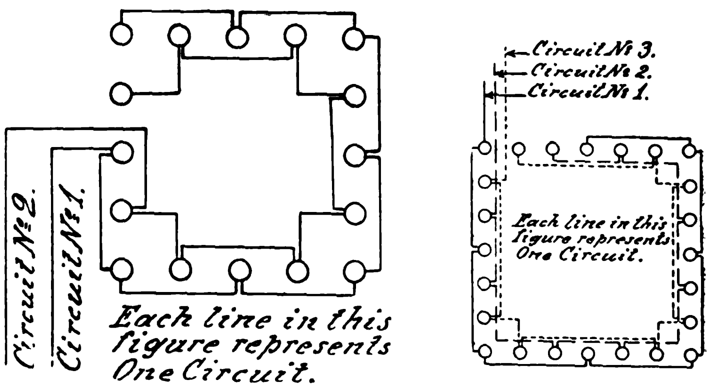

Circuit to Switch
Circuit from Switch
Switch
Branch Circuit to Outlet supplying 8 Lights
Distributing Centre
Branch Circuit to Outlet supplying 8 Lights
Branch Circuit to Outlet supplying 8 Lights.
Mains
24 Light Outlet.

FIG. 1.—SWITCH CIRCUIT.


Circuit No 2
Circuit No 1
Each line in this figure represents One Circuit.
Circuit No 3.
Circuit No 2.
Circuit No 1.
Each line in this figure represents One Circuit.

FIGS. 2 AND 3.—TWO AND THREE CIRCUIT ARRANGEMENTS.

Now, however, it is considered almost essential (except perhaps in office buildings and stores) that all ceiling lights be controlled by a local switch placed at a convenient point for turning the lights on or off. In many cases the side bracket lights are also thus controlled. The greater convenience of controlling the lights by a switch, instead of by means of the key at the lamp, is unquestioned.

Aside from the matter of convenience, however, there is another point in favor of the increased use of local switches, and that is the cost of operation. In certain ways the comforts of our time have undoubtedly made us lazy. A door at the entrance to a public building nowadays, which has no automatic closing device, is very liable to be left open. People expect that it shall be closed without the effort required to close it.

So it is with lighting. If, after a person is through using the lights in order to turn them off he has to put himself to any great inconvenience, he is very apt to "forget" it (unless he has to pay for the lighting himself), and allows them to remain burning, while if the lights are controlled by a local switch placed conveniently near the point of exit from the room he is much more likely to turn them off. In fact, to the average person there is more or less fascination in a push button or rotating snap switch, and he more than likely takes some pleasure in turning the lights off by these means.

In many cases, therefore, the reduction in the amount of current consumed, due to using local switches, will, in a few years, overbalance the cost of installing these switches. Of course, where it is essential to keep the first cost or the cost of the wiring installation down, they have to be omitted.

In office buildings switches are not so necessary, as the brackets and desk lights are more used than chandeliers, and are therefore more easily turned on or off. Beside, after the tenants leave their room the cleaners come in, and when they go out they are required to turn off all the lights.

In private houses, hotels and in similar places, the chandeliers certainly should have switches, and it is becoming very common now to use them for controlling the side lights also. Where the side lights are placed more than seven feet from the floor this is almost essential. It is frequently required that the ceiling lights and side lights should have separate switches.

In case of large chandeliers or large groups of ceiling lights it is generally wise to use one or more switches for the ceiling lights in order to obtain different combinations of control. Of course, this is almost necessary where there are more than twelve lights to be controlled by a local switch, for the only alternatives are either to run the supply to the switch, thence returning to the distributing center, and there subdividing into smaller circuits in order not to have more than 6 amps. fed through one fuse (fire underwriters' requirement); or else to use fixture fuses.

Where more than one local switch is neither desirable nor necessary for controlling a certain group of lights, the switch may control as many lights as its capacity will allow, and a wire (of sufficient size, not to exceed the required loss) may be run to the switch and then return to the distributing center, where the circuit will subdivide into circuits not carrying over six amperes, these circuits being run to the lamps. (See Fig. 1.)

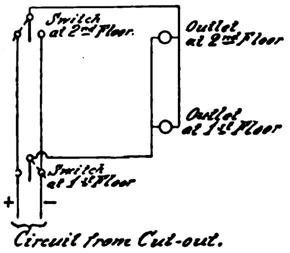


FIG. 4.—HALL OUTLETS CONTROLLED FROM TWO POINTS.

Where more than one switch is used to control a number of lights forming a chandelier the arrangement should be such as to get the greatest possible number of combinations of control; for example, it would be unwise to control a twelve-light chandelier in two groups of six each, for then we could have only two combinations —either half or all; whereas, if it were controlled in two groups, one of four and the other of eight lights, we could get three combinations—one-third, two-thirds, or all the lights.

If the lights are single-light outlets placed in rows or in the form of a square, etc., they are generally wired alternately, giving two combinations. Of course, more combinations can be obtained, but as this greatly complicates the wiring, it is not generally desirable. When it is done, however, care should be taken to have the outlets, occupying similar relative positions, wired on the same circuits, or controlled by the same switch. For instance, the outlets on the end of a row or at the corners of a square should be controlled together; otherwise the result would be unsymmetrical when one group of the lights was turned on. Figs. 2 and 3 show such groups controlled in two or three combinations respectively.

As to the location of switches in bed rooms, parlors, etc., they are best located near the doorway at a point most convenient when entering the room. In large rooms they are sometimes grouped together and placed in a box which is built in the wall back of a panel in the wainscoting. Where the switches control lights in public places, as in the halls or lavatories of a hotel, their location is largely a matter of taste. Some people want them placed so that nobody can "fool" with them, and therefore are placed in the cut-out cabinet or else in the switch lockers; while others want them to be more accessible and located in plain view near the outlets which they control.

For controlling a large number of lights from a point not near the distributing center, an automatic switch is sometimes used, which is controlled by a push-button circuit. Any number of push buttons at various locations may be used to control the switch, the switch itself being located at the distributing center. This switch, of course, performs the same function as a knife switch, but is operated by two electromagnets (or pairs of electromagnets) acting in opposite directions; these electromagnets are controlled by push-button circuits (of small wires), which are run to the desired points of control, the circuits being controlled by the push buttons. There may be any number of points of control without increasing the cost to any great extent, as the control wires are never over No. 14 B. & S. wire.

The advantages of these switches are that they save copper, as it would otherwise be necessary to run the main through which the lights were fed to the point of control and then back to the distributing center; they are also more convenient to operate than a knife switch. Their disadvantage is that they are likely to get out of order.

Automatic door-switches are sometimes used for controlling single lights in closets where the light is only required to be turned on when the door is open. These switches are single pole, and are nothing more than a push-button switch placed in the door casing in such a way as to be operated by the pressure of the door against the push button when the door is closed, and being so connected that when the button is pushed in the circuit is open. When the door is open the push button is forced out by a spring and the circuit is closed, thereby turning on the light. Their sole advantage is that they are automatic; their disadvantages are that they also are likely to get out of order. If the door is not closed the light, of course, is left burning; their position is such as to require cutting the door framing and casing; for this reason it is difficult to get more than one conduit to the switch, which makes it necessary to put this light on the end of the circuit.

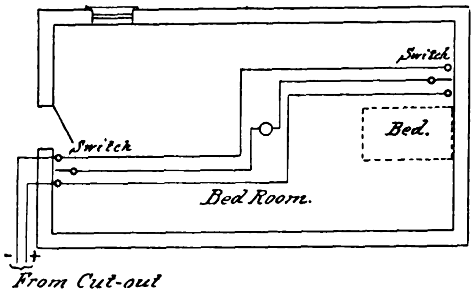


FIG. 5.—CEILING OUTLET CONTROLLED FROM TWO POINTS.

In a private house it is often desirable to have a portion of the hall lights so arranged that they may be turned on (or off) from the lower hall or entrance, and to turn them off (or on) from the upper hall or from one of the bedrooms. Switches for this purpose are specially designed, called "three-point" switches. The connections for such a circuit are shown in Fig. 4. These switches only break one "leg" of the circuit, and are therefore single-pole switches, and as the rules of the National Board of Fire Underwriters require double-pole switches for currents exceeding three amperes their use is limited to controlling a few number of lights only. They are also frequently used in rooms where it is desired to turn on the lights at one point and turn them off at another, as for instance in a bed room, as shown in Fig. 5. In this case the lights may be turned on in entering the room and turned off just before retiring. As will be seen from the diagram, the lights may be turned on or off from either point.

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AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

THE EXPRESS SYSTEM.

In the last article the main features of the Express system were discussed, but only those parts considered in detail which related to the apparatus and circuits enabling the subscriber to signal the central office. In Fig. 1 is shown a simplified diagram of the Express system. At the bottom and top of this figure are shown the subscribers' lines, leading in each case from the subscriber's telephone apparatus to the drop and jack at the central office. This part of the apparatus is the same as that shown in the last article, but in this figure the details of the local circuit at the subscribers' stations have been omitted for the sake of clearness.

The jacks and drops belonging to these lines are, as has already been stated, stationed at the "B" boards of the exchange. The subscriber's indicator battery is represented at S I B and the indicator at I I. Leading from the section of the "B" board shown at the top of the figure is a trunk line leading to a plug on the second section on the "A" boards. It will be noticed that this trunk line terminates in a plug at each end, and is termed the "A" trunk. An intermediate jack and plug are shown in the circuit on this "A" trunk, but these at present need not be considered. Suffice it to say that the plug at the "B" board is connected by a metallic circuit to the plug at the second section of the "A" board. Leading from a certain jack on the second section of the "A" board is a trunk line extending to a plug on another section of the "B" boards. This is termed a "B" trunk. Only one "A" trunk and one "B" trunk is shown for simplicity, but it must be remembered that a number of "A" trunks lead from each of the "B" boards to the "A" boards, and that from the "A" boards a number of "B" trunks lead back to each of the "B" boards.

When a subscriber, as for instance the one shown at the top of the figure, removes his receiver from its hook, his indicator, I, is displaced automatically, and the operator at the particular "B" board at which this indicator is located extends the circuit of his line to one of the "A" boards over an "A" trunk. This he does by inserting the plug of an "A" trunk into the jack of the calling subscriber. The operator at the "A" board having learned the desire of the calling subscriber, extends the circuit to that subscriber's line by the means of the "B" trunk still further on to the particular "B" board at which the jack of the called subscriber is placed. This the "A" operator does by inserting the plug of the "A" trunk used into the jack of a "B" trunk at her board. The "B" operator at whose board the calling subscriber's jack is placed then completes the connection between the two subscribers by inserting the plug of the "B" trunk used into the jack of the calling subscriber's line. The two subscribers' lines are thus shown connected in Fig. 1 by the process and over the circuits just described.

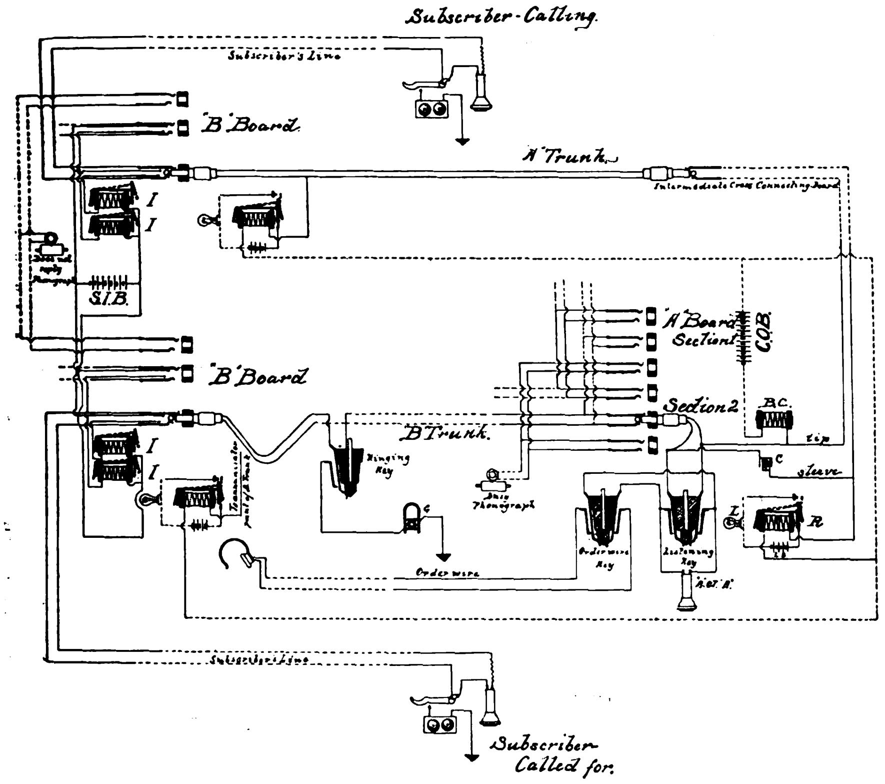

FIG. I.—SIMPLIFIED DIAGRAM OF EXPRESS SYSTEM.

In order to facilitate matters it is evidently necessary that a most complete and elaborate set of signals must be provided between operators. The first in this series of signaling operations is to notify the "A" operator that her attention is desired on a certain "A" trunk. This must always occur just after the "B" operator has inserted one of the "A" trunk plugs into the jack of the calling subscriber's line. It will be noticed in Fig. 1 that the relay, R, operating signal lamp, L, is bridged across the tip and sleeve strands of the "A" trunk circuit, and this bridge may be traced from the tip strand through the balance coil, B C, thence through the clearing out indicator battery, C O B, to the battery wire, thence through the coil of the relay at the "A" board, and thence to the sleeve strand of the "A" trunk. Remembering that the calling subscriber at the top of the figure has removed his receiver from its hook, then the insertion of the plug of the "A" trunk will restore the line drop, I, and at the same time will close the circuit from the clearing out indicator battery, C O B, and the relay, R, through the subscriber's line and telephone instrument. This will operate the relay and cause it to close the circuit of the signal lamp, L, thus calling the attention of the "A" operator to the fact that an unanswered call is upon the trunk line to which that lamp belongs.

The apparatus of the "A" operator is shown more clearly in Fig. 2. The sleeve and tip strands of the "A" trunk are shown at the extreme left of this figure. When the armature of the relay, R, is attracted as described above, the circuit from the local battery and white lamp is completed at the point, b, of the relay. It will be noticed that this local circuit extends through two of the springs, e and f, normally close on the listening key of the "A" operator, and also through a pair of contacts, l and c, held closed by the weight of the plug of the "A" trunk in its socket. The white lamp will therefore remain lighted until one of the following three things happens: Until the operator listens in, which causes the local circuit to break at the listening key; or until she removes the plug of that trunk line from its socket, which would break the local circuit at the point c; or until the calling subscriber hangs up his receiver, which would cause the relay to let go of its armature and thus break the circuit at point b. The white lamp remains lighted therefore as long as the call on its "A" trunk is unattended to.

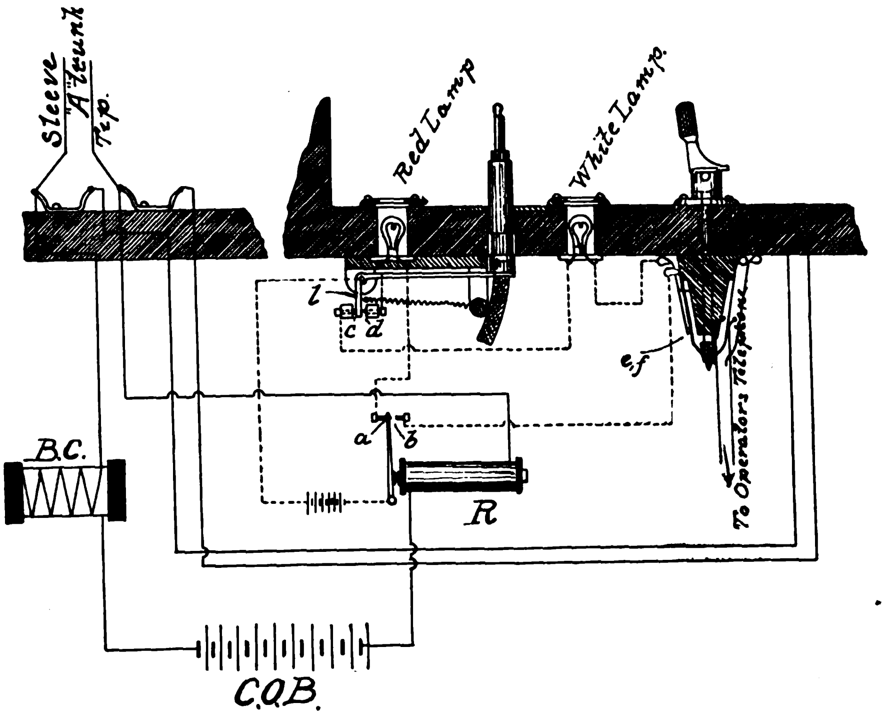

FIG. 2.—TABLE OF "A" BOARD.

The first act of the "A" operator on seeing this light is to throw her lever corresponding to that light into its horizontal position, thus connecting her telephone to the terminals of the "A" trunk in the usual manner. This enables the "A" operator to communicate with the calling subscriber in the ordinary manner. It should be noted that these keys on the "A" operator's boards are the only means afforded to any operators for communicating with subscribers. The operation of this key breaks the circuit of the white lamp at the points, e, f. As soon as the listening key is thrown again into its normal position the white lamp is again lighted, thus calling the operator's attention to the plug to be used in making the connection.

This precaution is a wise one, for before making the next move in the connection, the "A" operator must communicate with the "B" operator at whose board the called-for subscriber's line terminates. The "A" operator does this by depressing her order wire key, shown in Fig. 1, but omitted from Fig. 2, which act connects the "A" operator's telephone directly with the telephone set of the outgoing "B" operator. The "A" operator then tells the "B" operator the number of the line with which connection is desired, and the "B" operator in return tells the "A" operator the number of the trunk line she is to use in making the connection.

Herein lies one of the greatest defects of the system. That is, the necessary waiting by the "A" operator for the reply of the "B" operator. This is a loss of time on the part of the "A" operator, for it often occurs that the "B" operator may have several other connections under way which she could not well leave in order to reply to the "A" operator by designating the number of "B" trunk to be used.

It will be noticed that the trunk jacks of the "B" trunks are in reality arranged on the plan of the multiple board. This is for the purpose of placing within the reach of every "A" operator a jack belonging to every "B" trunk line. No test system, however, is required on these jacks, as an "A" operator always first learns from an outgoing "B" operator which "B" trunk to use, and of course a "B" operator would never designate any trunk which was already in use or "busy," as it is termed.

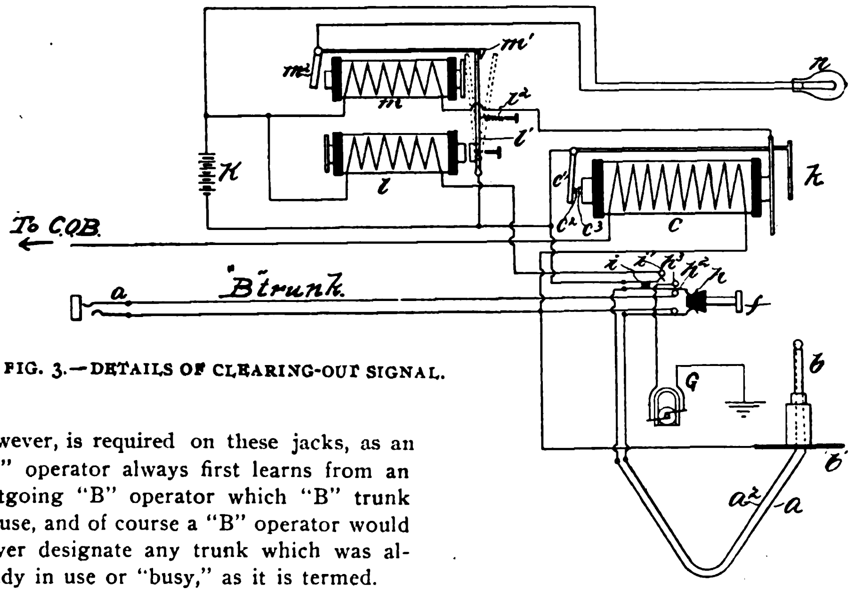

FIG. 3.—DETAILS OF CLEARING-OUT SIGNAL.

It would seem that a "busy" test, or preferably a visual "busy" signal for the multiple jacks on the "A" boards could be used with advantage. This would enable the "A" operator to at once select an idle "B" trunk and at the same time inform the proper "B" operator of the connection to be made and the trunk line plug to use in making it. For instance, the "A" operator could simply say: "1504 on 10," meaning by the first number the number of the subscriber called for, and by the second number the trunk line to be used.

We have now carried the connection, or extended the circuit of the calling subscriber's line, as far as the trunk line plug at the outgoing "B" board. The outgoing "B" operator then completes the connection by inserting this plug into the jack of the called subscriber. The "B" operator then depresses her ringing key, shown in a simplified form in Fig. 1, which sends calling current from the generator, G, over the sleeve strand of the plug cord, thence to line and to ground through the polarized call-bell at the subscriber's station.

The next feature to consider is that of the automatic clearing-out signals. As the connection between the two subscribers is made by three operators, it is evident that three distinct clearing-out signals should be given, one at each of the boards of the operators who help establish the connection. Turning again to Fig. 2, it will be seen that the raising of the "A" trunk plug from its socket changed the circuit of the local battery from the white lamp to the red lamp, by moving the selecting lever, l, from the point, c, to the point, d. Remembering now that as long as the calling subscriber's receiver is off its hook, the circuit from the clearing indicator battery is closed through the relay, R, at the "A" board, thus attracting its armature, V^1. As soon, therefore, as the calling subscriber finishes his conversation, he hangs up his receiver and thereby breaks the circuit through the relay at the "A" board, thus closing the circuit through the red lamp. This lamp will therefore be lighted as a notification to the "A" operator that disconnection on that trunk is desired. The replacing of the plug in its socket opens the circuit of the red lamp at the point, d, thus extinguishing the lamp.

The apparatus at the "A" board is very ingenious and deserves special attention. It should be noticed that should an operator by mistake remove one of the "A" plugs, and replace it in its socket before the subscriber connected had hung up his receiver, the white lamp would be relighted, thus calling the attention of the operator to the error. The clearing-out signal is given to the incoming "B" operator in much the same way as that on the "A" board, the clearing indicator, or relay, on the "A" trunk of the "B" board being wired in multiple with the relay on the "A" board.

The clearing-out signal on the outgoing "B" board is accomplished by much more complicated means, and will be explained by reference to Fig. 3. In this figure the ringing key, f, is shown in more detail than in Fig. 1. a^1 represents the "B" trunk line jack on the "A" board. In the normal position of the key the two strands of the "B" trunk are connected to the tip and sleeve of the corresponding plug on the outgoing "B" board. When, however, the key is depressed, the sleeve strand of the cord is connected with the calling generator, the other terminal of which is grounded. When the operator depresses this ringing key, a secondary pair of contacts, i, i^1, are closed, thus actuating the lower magnet, l, of the compound relay, and causing it to attract its armature, l^1. When the operator allows the key, f, to rise the armature, l, falls back but is caught by the hook, m^1, of the upper coil, m, of the relay. The hook, m^1, and the tip of the armature are platinum pointed, and their contact causes the signal lamp, n, to be lighted. This lamp remains burning until the called subscriber takes his telephone off the hook, which act closes the circuit through the combined clearing-out relay and signal, c, in exactly the same manner as the relays on the incoming "A" trunk line were operated. The operation of this relay therefore closes a circuit at the points c2, c3, through the upper magnet, m, causing it to raise the hook, m^1, and allow the armature, l^1, to drop back. This extinguishes the lamp, n, and shows the operator that the subscriber has responded. The armature, c^1, of the relay, c, remains attracted until the called subscriber hangs up his receiver, which de-energizes the magnet, c, and allows the signal carried by the armature to resume its normal position. This is the clearing-out signal for the outgoing "B" operator, and she accordingly pulls out the plug.

To review the action of the indicators at the outgoing "B" board, the releasing of the key for transmitting a calling signal to the subscriber lights the lamp, n, and shows the operator that this part of her work has been attended to. The response of the subscriber is indicated by the going out of the lamp, and by the raising of the signal, k. The clearing-out signal is given by the lowering of the signal, k.

We have now traced through the operation of all of the signals between the subscribers and the operators, and between the operators themselves, which were necessary to establish a connection between two subscribers; and also the subsequent signals between the subscribers and the operators, indicating that a disconnection is desired. The striking feature of all this elaborate system of signaling is that each signal is automatically given without the volition of the operator or subscriber, inasmuch as it is brought about by some action necessary in the actual connection or disconnection.

In order to reduce the work of the operators to the last degree, two phonographs are placed in connection with the exchange, one of which is constantly and politely repeating the sentence, "Busy. Please call again," while the other repeats with equal regularity, "Subscriber called for does not reply." Each of these phonographs speaks to a transmitter arranged in connection with an induction coil and battery in the ordinary manner. The terminals of the secondary of the induction coil of the "busy" phonograph terminate in a jack on each section of the "A" boards. In like manner the "does not reply" phonograph is connected with a jack on each section of the "B" boards. When, therefore, an "A" operator learns that a line called for is busy, she inserts the plug of the "A" trunk to which the calling subscriber is connected into the phonograph jack, and the familiar but disappointing message, "Busy. Please call again," is automatically conveyed to the calling subscriber.

In a similar manner the outgoing "B" operator may inform the calling subscriber that the subscriber called for does not respond. The use of the phonograph for this purpose may seem at first thought to be carrying the labor-saving idea to an extreme, but it enables an operator to attend to another subscriber while she is telling the first subscriber that his line is busy or that his party does not respond. It moreover insures that the wrath of the calling party will produce no evil effects on the nerves of the operator, which at busy times is no unimportant consideration.

The writer is indebted to an able article by Mr. George P. Low, in the "Electrical Journal" for much information concerning this very interesting exchange system.

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LESSONS IN PRACTICAL ELECTRICITY

REGULATING ALTERNATING CURRENT LINE VOLTAGE BY MEANS OF SYNCHRONOUS MOTORS OR ROTARY TRANSFORMERS.

When alternating current transmission of power in large quantities was first brought forward, it was thought that the drop due to line inductance would prove a serious obstacle. As has been explained in previous lessons, a circuit carrying an alternating current becomes a generator of e.m.f. through the cutting of lines of force in and out of the loop forming the circuit as the current rises and falls in value. The e.m.f. thus set up is a counter e.m.f., which reduces the line e.m.f., or gives rise to a drop similar to the drop due to resistance, though, unlike the latter, involving no direct loss of energy. Such drop, however, interferes with regulation, and also increases the C^2R loss on account of the additional current required to transmit a given amount of energy, such additional current being required to compensate for the e.m.f. neutralized by the counter e.m.f.

Steinmitz has shown, however, that the inductive drop may be counteracted by having in circuit a synchronous motor or, what amounts to the same thing, a rotary transformer, the field of which is given a high excitation, or, as usually expressed, is over-excited.

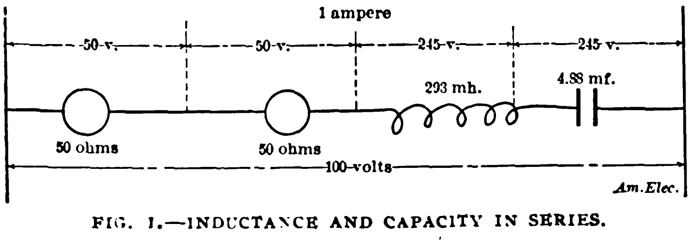


FIG. 1.—INDUCTANCE AND CAPACITY IN SERIES.

Such a motor or transformer placed across, for example, constant potential mains, has in its circuits three e.m.fs.—the impressed e.m.f. of the line, the counter e.m.f. of the armature, and the e.m.f. due to the inductance of the armature. The phase relation between the impressed e.m.f and the current evidently depends on the respective values and phase delations of these three e.m.fs.

Now, the synchronous motor, or the rotary transformer, has its field excited by continuous current, and as the speed of the armature is fixed by the frequency, it will thus be seen that as the strength of the field is changed in value, the counter e.m.f. will also be changed proportionately. Furthermore, such machines may be designed with values of armature inductance and strength of field, that the relation between the several e.m.fs. will be such that the current flowing will lead the impressed e.m.f. In other words, such a motor may be made for the purpose in question to act as the equivalent of a condenser.

Referring to Fig. 2, suppose that with a given current flowing in such a motor, O R is the drop in the armature due to resistance, and L R the drop due to inductance, this latter, of course, being at right angles to the ohmic drop. Then O L will be the resultant, or the total drop in the armature due to the alternating current passing. Suppose, now, that O C represents the counter component of the e.m.f. which overcomes e.m.f. Since the impressed e.m.f. must be the resultant of the counter e.m.f. and the armature inductive e.m.f., its value will be represented by the line O E, the diagonal of a parallelogram, whose sides are O L and O C. In the triangle L O R, the angle L O R is the angle of lag between the armature e.m.f. and the current: this follows, for the reason that, first, as explained previously, an inductance in a circuit causes the current to lag behind the e.m.f.; and, second, that the current flowing in a circuit must be in phase with the ohmic resistance. Consequently the angle R O E is a leading angle, and signifies that the current leads the impressed e.m.f. O E.

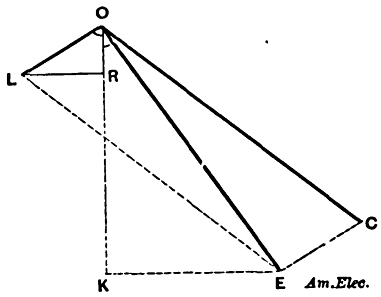
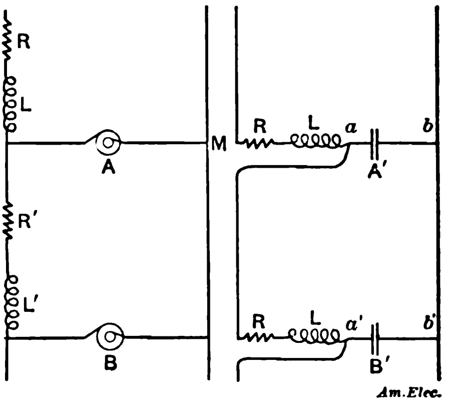


FIG. 2.—DIAGRAM OF E.M.FS.

If the line O R is prolonged to K, and a horizontal line drawn from K to E, then the two lines will represent the components of the impressed e.m.f., the vertical component being in phase with the current and the horizontal component at right angles to the current. This latter, or K E, would be the same as that derived from a condenser were it in circuit, the motor thus being equivalent, so far as neutralizing inductance is concerned, to a condenser that would set up an e.m.f. having the value of K E.

In the example illustrated in Fig. 2, part of this condenser e.m.f. would be neutralized by the inductive e.m.f., L R, of the armature, the remaining portion neutralizing, partially or entirely, the inductive drop of the line; or, if of sufficient value, neutralizing both inductive and ohmic drop, or even raising the voltage of the line beyond the motor above the voltage at the terminals of the generator, if there is added to the line inductance additional inductance in the shape of choke coils.



FIGS. 3 AND 4.—MOTOR AND CONDENSER CIRCUITS.

The manner in which a voltage may be raised by an inductance and condenser in parallel is shown in Fig. 1. In this case the line voltage is 100, but the current passing in the circuit between the mains will, as shown, give rise to a voltage of 245 volts between the terminals of the inductance, and 245 volts between the terminals of the condenser. Since, however, the inductive voltage is in the opposite direction to the capacity voltage, the two will neutralize each other, so that the circuit will act as if it possessed neither inductance nor capacity. If, now, a line were to lead away from the terminals, for example, of the capacity, we would have a voltage of 245, or 145 volts more than that of the main circuit.

Referring now to Fig. 3, suppose A and B are synchronous motors or rotary transformers on a constant-potential line. Furthermore, suppose that R represents the resistance of the line from the generator to the motor A, and R' the resistance of the line from the point N to the motor B, L and L' being the corresponding values of the line inductance. Bearing in mind what has gone before, it will be seen that the case is similar to that of the right hand side of Fig. 4, where A' and B' are condensers, and the similarity of this latter figure to Fig. 1 will also be noted.

If the condenser value of the motor A is such as to neutralize the drop due to both L and R, then the voltage at a b will be precisely the same as the generator voltage. Similarly, if the capacity e.m.f. value of B is such as to neutralize the drop of L′ and R′, the voltage of a′ b′ will also be equal to the generator voltage.

In case it is merely desired to neutralize the inductive drop, the motor is designed to give rise to a capacity e.m.f. equal to the inductive e.m.f. of the line. If, on the other hand, it is also desired to neutralize the ohmic drop, or to over-compound—that is, to have at any given point of the line an e.m.f. higher than the generator e.m.f.—it is necessary to introduce into the line an inductance, the field excitation of the motor, of course, being made such as to produce a capacity effect sufficient to neutralize this inductance, as well as the line inductance.

To resume, by means of a properly designed synchronous motor or rotary transformer placed in circuit on a transmission line, the inductive drop of the line may be neutralized; or, by introducing an inductance or choke coil in series with the line, both the inductive and the ohmic drops may be neutralized; or, by introducing a still larger inductance in the line, the voltage at and beyond the motor may be made higher in value than the voltage at the generator.

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Letters on Practical Subjects

Arc Dynamo Air Blasts.

To the Editor American Electrician:

I was interested in the letter in a recent issue from Mr. R. H. Sterling, describing his method of repairing the air blasts of T. H. arc dynamos.

His method is all right so far as it goes, but the writer believes that prevention is better than cure, and to do away with this troublesome device is far better than repairing it. I have made blowers and wings of many materials, with the idea of getting more weight in them, and thus obtaining more air pressure, most of which, while giving a 10-pound pressure, would either batter or break or crumble. The best results have been achieved by the use of an aluminum-nickel alloy. The only objection that I had against this is that the blower had to be opened once in three weeks to file off the projecting edge of the wing, which became spread out like a soft hammer; otherwise, these wings gave splendid service, and there was no flashing on 55 lights.

Not satisfied, however, the writer determined to dispense with the blowers altogether. My present arrangement consists of an air pump and reservoir, adapted to stand a working pressure of 100 pounds; a reducing valve, regulated to reduce to 10 pounds and to hold it steady; and a pair of insulated nozzles for each machine having openings of 1-64-in., the nozzles being connected to the fixed piping by heavy ¾ or ½-in. hose; a high and low pressure gauge, with dirt strainer, and the necessary valves, complete the outfit.

With this arrangement a 50-light 2000-c.p. machine will carry 60 lights, with absolutely no flashing, and do so right along.

The interior parts of the air blast are removed and the oil cup done away with, thus preventing the machine from being smeared with oil, as is usually the case. The commutator is oiled by hand, the same as other dynamos, by a stick having leather facings, which are oiled from a small dish of castor oil. The gain in cleanliness is surprising. I expect soon to overcome the last objection named, the oiling of the commutator.

Any company operating five or more 50-light dynamos of the make named should, in the writer's opinion, install a pneumatic outfit as described, and compress air during the day when boilers are underworked and often blowing off. If there is an incandescent day circuit, so much the better, as then the air compressor can be motor-driven, or it may be belted to the main engine. It is well to avoid, however, the small steam direct-acting compressors, as they consume an enormous amount of steam.

The feeling of security and reliability accompanying this device is of immense value, and I shall be glad to furnish any further information desired.

H. Franklin Watts.

Philadelphia.

Induction Coils.

To the Editor of American Electrician:

The advantage of increasing the length of the core of the usual form of induction coil does not seem to be generally known. The core should be at least 40 per cent. longer than the secondary winding, which greatly decreases the magnetic reluctance. I was able to increase the length of spark of a certain coil from 1½ to 3 ins. by thus increasing the length of core. As the vital part of all induction coils is the insulation, if paraffine is used, care should be taken not to overheat the material, since overheating impairs its insulating qualities.

H. J. Gooding.

Wilmington, Del.

Resistances of Telephone Induction Coil.

To the Editor of American Electrician:

There is evidently some mistake in the answer to a query about a telephone induction coil given in your May issue.* The resistance of the primary would be about 60 ohms, using No. 36 wire, 150 turns on a 9/16 core, and the amperage of the primary circuit would become excessively low. With a primary winding of 60 ohms, a transmitter resistance of 10 ohms, and a battery resistance (two cells Leclanche) of 1 ohm, the total resistance would be 71 ohms, giving a current of only 0.04 amps. But the resistance of the primary is increased, as the current is not a steady one, but an undulatory one, on account of its inductance.

The right size of wire should be No. 20 or 21, with about 180 turns in two layers, and about ½ ohm resistance.

As to the right resistance of the secondary, opinions differ. Some manufacturers advertise coils with 750 and 1000 ohms resistance, but they do not give such good results as 500 and 250 ohms coils, on account of the enormous impedance. I found that on most lines, especially when bridging bells are used, coils with a resistance of 50 to 75 ohms gave better results than those with high resistance secondaries. They will give the best satisfaction on lines having a resistance less than 2000 ohms.

Inductive resistances, i. e., series bells, are very bad in a telephone circuit. If bridging bells cannot be used on account of a long line and unequal distribution of instruments, series bells will give good results if shunted with condensers of sufficient capacity to balance the inductance of the bells. But the cost of condensers renders their use in telephoning prohibitive.

Henry P. J. Van Deth.

Stroudsburg, Pa.

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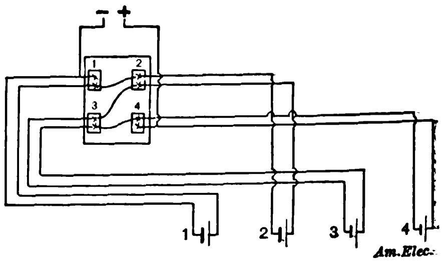
* The data were given on the authority of Dr. Wittelsbach.

Telephone Connections.

To the Editor of American Electrician:

We use four cells of gravity battery on our exchange transmitter, and some annoyance has been caused to the operator when a cell was disconnected to be cleaned. The following arrangement was therefore installed:

Four single-pole W. U. style fuse blocks of the American Electric Fuse Co. were wired as shown in drawing. By placing a strip of brass in a fuse block, the corresponding cell is cut out by short circuiting. The cell can then be removed without breaking the current, and when replaced it is merely necessary to remove the brass strip, which throws it into circuit.



TELEPHONE CONNECTIONS.

Karl B. Davis.

Middletown, Ind.

Efficiency of Electric Heating Apparatus.

To the Editor of American Electrician:

In a recent issue of an electrical journal the statement was made that all electric heating devices have the same efficiency, and that a certain amount of electrical energy expended on a heater, no matter what its form or construction, would produce a certain definite amount of heat.

This is so obvious from the consideration of natural laws that it cannot very well be contradicted. Nevertheless, I have been confronted with the curves of efficiency obtained in a practical test of two electric heaters in raising the temperature of a small room, and it is found that for a given number of watts the temperature obtained in a given time was much greater in the case of one heater than the other; also, that the maximum temperature possible for a given number of watts was greater with one than with the other heater. From their construction the radiation might have been more rapid in one than in the other, but the test lasted two hours and the maximum temperature above referred to was measured at the end of the time.

Will you kindly enlighten one who has not given heating problems any particular study as to how to account for this apparent contradiction? In the less efficient heater where does the extra heat go?

L. T. RICE.

Ottawa, Can.

An Electric Alarm Attachment for Clocks.

To the Editor of American Electrician:

The following illustrations show how an electric alarm may be attached to any clock at trifling cost, and with materials which the average electrician usually has at hand. Fig. 1 shows the common type of dial for setting a mechanical alarm, which in this case will be used with a slight addition. After removing the pendulum, hands and face, pull or take off the alarm dial, which is only held on by friction; make a fibre cam, the duplicate of *F*, but a little larger in diameter, so it will not make contact anywhere, as shown in Fig. 2. In Fig. 2 the fibre is cut away so that the alarm will ring about a half hour, but it can be made to ring any length of time desired by filing the fibre more or less. Drill a hole in the fibre a little small, so it will fit snugly on the dial shaft, and set it so the point of the cam will come directly under the hour of XII. The reason for this is that in this type of alarm the hour set to ring stands directly under the hour hand of the clock; if it does not, this rule will not hold good.

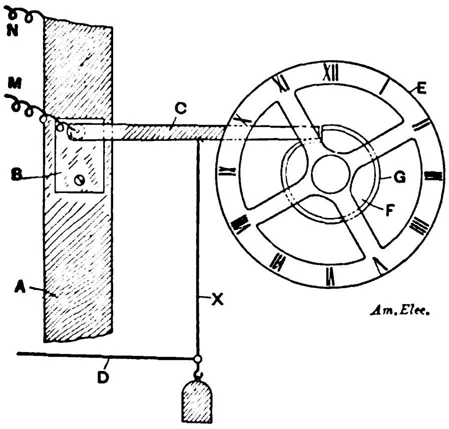
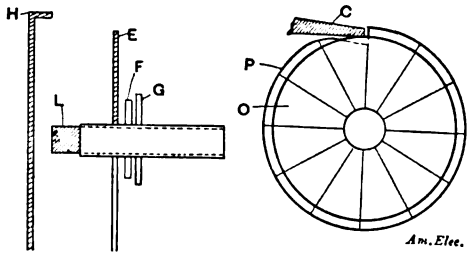


FIG. 1.

Fig. 3 is a side view of alarm dial, the letters referring to the same parts as in Fig. 1, excepting *L*, which marks the hour hand shaft. The small lever *C* must be removed and insulated from the works by riveting *C* to a small piece of fibre, *B*; utilize the screw which fastened *C* and *A* to screw the fibre *B* to *A*; drill a hole in *A* under the rivet to prevent grounding on *A*; suspend a small weight from *C*, so as to insure good contact; or weight *C* on its contact end by a bunch of solder. The wire may also be adjusted so that the mechanical alarm will ring at the same time. *D* is a guide to keep *X* from grounding; *H* is a top view of *C*. Now solder a small wire, *M*, to the rivet and run it to a single point switch on the side of the clock, the wire *N* from *A* running to one side of the bell. Connect the parts as shown in Fig. 4, and we are ready to test. Make sure that *C* is not grounded to any part of the clock; be careful that *C* makes contact to *F* directly under the hour XII of both dials; for example, if we desire the alarm to ring at 6 o'clock, as in Fig. 4, set the hour 6 of the alarm dial directly under the hour hand of the clock.



FIGS. 2 AND 3.

For clocks which have no alarm dials, make one, as in Fig. 2, *O* being a thin brass or copper washer about 1½ ins. in diameter and *P* a fibre washer ⅛ of an inch thick. Rivet *O* and *P* together, paste a piece of white paper on the front of *P* and lay off the hours on it in good black ink; drill a hole through the centre of *O* and *P* so that they will fit snugly on the hour hand shaft, directly under the hour hand; then file away *P* to adjust the length of time of contact. Cut a hole in the face of the clock 2 ins. in diameter so as to allow room for setting, and otherwise follow directions previously given.

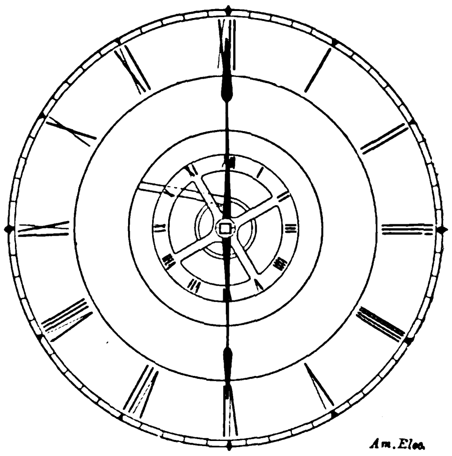


FIG. 4.

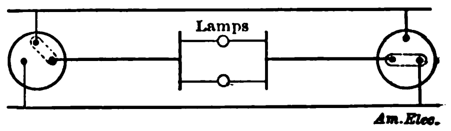
WALLACE BELMONT.

Omaha, Neb.

Three-way Switch.

To the Editor of American Electrician:

The sketch herewith shows a three-way switch which I have found very satisfactory, and which is different from the others which I have noticed in the last few issues of your paper, and requires less wire. I also enclose a very convenient arrangement of the Ohm's law formula, which does away with the memorizing of all three formulas. The method of using is as follows: If you wish to find the E. M. F. place your finger over the letter *E* and you have left *C*×*R* which gives the desired E. M. F.; if you wish to find the *C* or *R* place your finger over these respective letters, and the letters remaining indicate the desired formula. Thus the one formula only need be memorized.



3-WAY SWITCH.

The formula is as follows:

$$\frac{E}{C \times R}$$

Covering the *E* makes it $\frac{\quad}{C \times R}$.

" " C " " $\frac{E}{\times R}$.

" " R " " $\frac{E}{C \times}$.

Mansfield, O. **ALBERT S. WILSON.**

Testing-Set Batteries.

To the Editor of American Electrician:

So many inquiries have reached me regarding the construction of a suitable battery for use with the Wheatstone Bridge testing set, described in this journal, that it will be in order to devote a letter to the battery question. At the time of writing the articles in question, the entire matter on batteries was, on account of the great length of the descriptive matter, omitted entirely, hence the seeming incompleteness of the articles at that point.

For any bridge that is to be used constantly, or for considerable periods of time, I would under no circumstances whatever recommend the use of small cells that can be placed in the lid of a box as described. Even when the instrument is to be used in the same place occasionally, I would by all means set up a few cells of any good open circuit battery, and let the little cells in the box severely alone.

It is only when the box is to be used "on the road," so to speak, that the small battery in the lid is desirable. If I was inspecting the insulation of isolated lighting systems, or testing the insulation of house wirings, then the portable battery is not only desirable, but necessary. But for general use it is very unsatisfactory.

The battery described in a recent letter, made of silver plate, over which silver chloride has been fused, is known and described in the text books as the "De la Rue" cell, and it is the strongest cell commercially known at present. So many complaints of unsuccessful attempts to make up this cell have been sent to me that I am led to advise the use of some other, unless the silver chloride cells be purchased complete. They are on the market.

For occasional testing, plain cells of zinc and carbon, with the blotting paper wet with common sal-ammoniac solution, will work very well, and form a very cheap and efficient battery, provided their use is not steady enough to cause polarization. Some cells which will run quite steadily without polarizing are made of two thin carbon plates, 1 x ⅜ in., with finely pulverized black oxide of manganese placed between them, then the double plate is wrapped in blotting paper and treated exactly as described for the elements in the original description of the instrument.

JAMES F. HOBART.

Brooklyn, N. Y.

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Animal Horse Power.

To the Editor of American Electrician:

In your issue for April there is a question in regard to the number of horse-power required in an engine or electric motor to take the place of 14 horses. By long experience in the New England States with tread-mill horse-power, it is found that it cannot be replaced and do satisfactory service, unless the number of horse-power furnished in the engine is at least twice as great as the number of animals employed on the tread-mill. The reason for this is found in the fact that horses are not often worked continuously in the tread-mill. In many parts of New England the animals are driven almost up to a trot, and the railway horse-power, as it is called, is set at a very high angle, usually much higher than manufacturers intend. At this rate of speed horses can work for a short time only and then are compelled to rest.

In sawing wood, this rest is made use of to bring up a new supply of sticks and perhaps to take away that which has been sawed. In these short spurts horses sometimes do more than double the amount of work represented by a horse-power. It would, therefore, be impracticable in furnishing machinery to satisfy the demands of those who have used horses for motive power, which would do not less continuously than the horses can do at a spurt.

In the question referred to, the animal horse-power supplied should be 28, and with the 6 reserve which you properly added, the total would be 34 or 35. This would enable the work to be rushed and would probably give satisfaction.

It must not be supposed that horses can work at this rate for any length of time. The horses used in threshing, after the season is over, are notoriously in bad condition, and those sawing wood in the spring are equally thin and pretty well "played out" when wood sawing is over.

R. G. COTTRELL

Boston, Mass.

ELECTRICA CATECHIS

214. How can one calculate the force with which a magnet attracts another magnet or a piece of iron?

The force between the two equals the area of the common surface multiplied by the square of the number of lines of force per sq. c.m. divided by 25.14, or multiplied by 0.04. For example, suppose two pieces of iron 1 c.m. square and of any convenient length are bent into half circles and that the current is sent through a coil of wire wound about one or both pieces so as to magnetize the iron to a saturation of 5000 lines per sq. c.m.; the force at each joint between the two parts of the ring will be

$$0.04 \times 1 \times 5000 \times 5000 = 0.04 \times 25{,}000{,}000 = 1{,}000{,}000 \text{ dynes;}$$

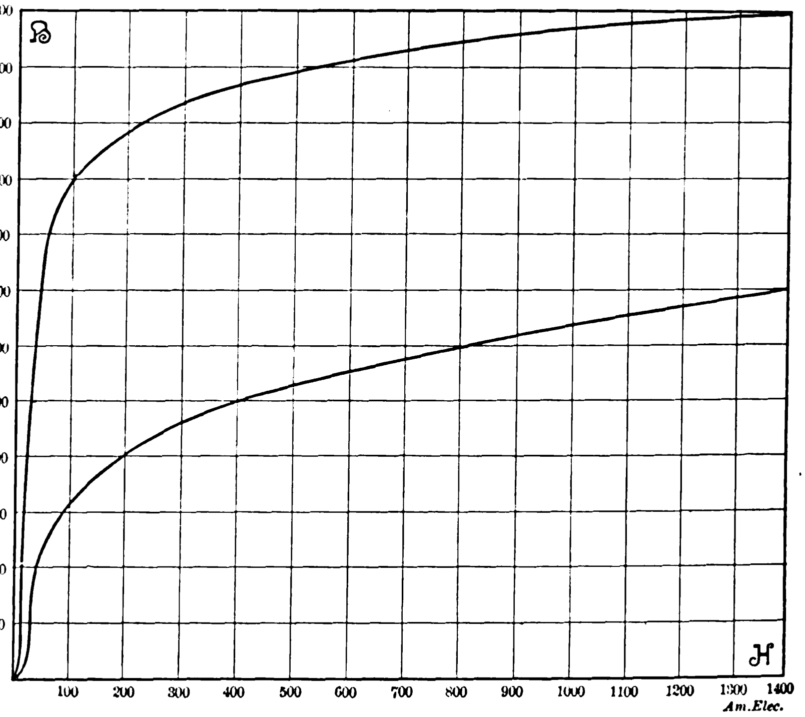
the total force will be the sum of that at the two joints, or double that at one, hence the total pull is 2,000,000 dynes. Since 981 dynes equal the weight of one gramme, the total pull between the two pieces is

$$2{,}000{,}000 \div 981 = 2024 \text{ grammes,}$$

or about 4.4 pounds.

215. How can this rule be modified for English measures?

Four hundred fifty-three and six-tenths grammes equal one pound. Hence if the dimensions and saturation are given in centimeters, the pull (in pounds) at each pole equals the area multiplied by the square of the number of lines per sq. c.m. divided by 25.14 times 981 times 453.6; or divided by 11,183,000. If English measures are used throughout, the rûle becomes: The pull (in pounds) equals the total area of contact (in square inches) multiplied by the square of the number of lines of force per sq. in. divided by 11,183,000 times 6.45 or divided by 72,134,000.



216. Give an example of calculating the pull of a magnet.

Suppose the magnet is made of iron 1½ x 1¼ ins., bent into U-shape and magnetized to a saturation of 40,000 lines per sq. in. The area of the iron is 1.875 sq. ins. at each end. The pull at each end is

$$\frac{40{,}000 \times 40{,}000 \times 1.875}{72{,}134{,}000} = 41.6 \text{ pounds.}$$

The total pull for both ends will then be twice this, or 83.2 pounds.

217. Is the above rule for the pull of a magnet rigorously correct?

It supposes that the magnetism is uniformly strong over the whole end of the magnet. If the contact between the magnet end and the piece it is lifting is equally good over the whole surface, the magnetism will usually be equally distributed and the rule in its simple form holds true. If the magnetism is stronger in some places, then the rule becomes more complicated.

218. How strongly can iron be magnetized?

There is no definite limit. Cast iron is well saturated at 40,000 lines per sq. in., or 6200 per sq. c.m. Wrought iron is well saturated at 100,000 lines per sq. in., or 15,500 lines per sq. c.m.

219. What is meant by iron being saturated?

When iron is subjected to a magnetizing force such as a current through a coil of wire surrounding the iron, the magnetization of the iron increases very rapidly at first as the current increases from zero. After the current has reached a certain value, any increase has less and less effect. This is illustrated in Fig. 1, in which horizontal distances represent magnetizing force and vertical distances represent the resulting magnetization of the iron. The turning point in each curve is called the point of saturation, being at about 100,000 for wrought iron and 40,000 for cast iron. These values vary with the quality and treatment of the iron.

QUERIES AND ANSWERS

Note.—Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied.

What is the liquid used in polarity indicators? E. B. M.

Iodide of potassium dissolved in glycerine is used for this purpose.

How many pounds of wire are required for the armature of the motor described on p. 280 of July, 1897, number? R. B. C.

Not quite two pounds.

What metal or substance will act as a positive insulator of magnetism? D. W. S.

None. An object may be screened from magnetic influence by means of an iron envelope.

What voltage and current is necessary to charge a storage battery? D. W. S.

About 2½ volts per cell, and 8 to 10 amperes per square foot of positive surface, including both sides of the plates.

In the article in the May number on "A Universal Motor and Dynamo" the working drawing gives the diameter of the d.c. motor field as 2⅛ in., and the text as 2½-in. Which is correct? T. E. O.

The text is correct.

Can the 50-volt dynamo described in the February, 1897, number, be used to run an arc light, and, if so, what size of carbons should be used? G. L. B.

Yes; use an ordinary constant-potential arc lamp burning 7-16 in. carbons.

What is the capacity of a storage battery of two positive and three negative plates and its discharge rate? L. A. V.

About 80, 70 and 60 amp.-hours for 8, 5 and 3 hours, respectively. The normal discharging rate is about 10 amps.

Does it make any difference on which leg of a circuit an ammeter is placed? H. R.

No, except in a case when it is not desirable to cross wires, when the leg making straight connection may be determined by trial at a switch or fuse.

Where is the voltmeter connected in testing an arc lamp? B. R.

It is customary to connect to the terminals, though it is sometimes desirable to find the e.m.f. across the arc, the difference being the drop in the mechanism.

How can I change a battery induction coil to work on a 110-volt circuit? J. N. P.

Find what battery current is used, and adjust the current from the lighting mains to the same value by means of incandescent lamps in parallel, or other non-inductive resistance.

What is a booster? M. L.

A booster is a dynamo, usually operated by a motor, placed in the circuit of a feeder to boost its voltage above that of the switchboard. All of the feeder current flows through the booster, which acts like an extra cell placed in one of several circuits leading from a battery.

Why does the following brushes of a Wood arc machine vary in distance from the leading brush? J. S.

When the regulator separates the brushes, the segments between them are short-circuited, the voltage of the machine thus being reduced. When the brushes are approached to each other, the converse is the case.

It is necessary to have a line of No. 2 B. & S. wire to carry a certain current a distance of one mile; would a line of 4 No. 8 wires already up carry the current if connected together in pairs? L. A. V.

Since a No. 2 wire has a cross-sectional area of 66,370 circular miles, and a No. 8 wire only 16,510 circular miles, the drop would be double with a pair of the latter.

I have a boat (bluff in form) about 34 ft. long, 7 ft. beam and 18 in. draft, which I wish to fit with electric power to run 10 miles per hour. What h.p. is required, and what should be the dimensions of the screw? J. D.

About 19 h.p. With a screw of 20 ins. diameter and 18.5 pitch, the speed will be 762 r.p.m. The speed is too high and the boat too large for electric power.

I am electrician of a summer hotel and find it convenient to use connectors in the case of mains that are taken down for the winter. I have been informed that connectors should not be used, and shall be glad if you will tell me the reason. J. W. M.

Any unsoldered joint apt to become loose is a source of danger through the heat thereby generated.

Can water be electrolized in sufficient quantity to run an oxy-hydrogen lamp, and what voltage is necessary? E. H. B.

Not economically. Over 3 h.p.-hours will be required to electrolyze one pound of water. As the voltage is only 1.7, this corresponds to a very large current, requiring a large electrode surface, if a single cell is used.

By holding the receiver of a telephone in front of the transmitter and short-circuiting the line, a whistling sound is produced; what is the cause of this? F. L. S.

This may occur from a slight vibration of the transmitter, which will change the resistance of the carbon; the effect of the vibration will be increased by the telephonic action of the receiver on the diaphragm of the transmitter.

We have two direct-connected units of 80 k.w. each, running on the three-wire system. Both machines run from 6 p. m. to midnight; one from midnight to 8 a. m., and the other from 8 a. m. to 6 p. m., in the latter case the polarity of circuits being changed. Could we use wattmeters or recording ammeters in this case? H. C. P.

Yes, with a pole changer. It will be best to put the steady load on one side of the three-wire circuit and use pole changer at switchboard.

What are the relations of the voltages between the conductors of a four-wire, three-phase circuit, and three-wire, two-phase circuit? J. S.

In the first case, if the voltage between the fourth or neutral wire and any of the three main wires is 1000, the voltage between the main wires is 1728. In the second case, if the voltage between the large wire and either of the smaller ones is 1000, the voltage between the latter two is 1410.

Is not the e.m.f. of self-inductance liable to injure a shunt machine if the circuit is suddenly broken? What protection may be used? A. D. L.

In large machines, yes. A pilot lamp affords some protection; copper shields around the field coils have been used; a simple method is to connect the shunt terminals with two carbon plates separated by a thin piece of perforated mica, a small fuse being also placed in the circuit.

How can I make a small electric heater for heating coffee? A. D. H.

Coil iron, steel or German silver wire on an asbestos pad, insulating the convolutions with asbestos thread. Iron and steel wire have about 6 times the resistance of copper wire, and German silver wire about 12 times. The lengths per ohm of copper wire at 170° F. are 80, 63, 50 and 40 ft., respectively, for Nos. 20, 21, 22 and 23 wire. From the above data the length of wire for any given current can be found. As an example, for No. 22 iron wire and 5 amps. on a 110-volt circuit, about 220 ft. of wire will be needed.

I want to use 19 magnets in series with 25 dry batteries. What should be the resistance of the windings? C. M.

For maximum effect, the combined resistance of the magnets should equal the internal resistance of the batteries, plus the resistance of the line. To find the former, if unknown, place the cells in series and short-circuit through an ammeter; the internal resistance of the cells will then be the combined e.m.f. divided by the current. To this add the resistance of the line, and dividing by the number of magnets will give the resistance of each. The size of wire will depend upon the dimensions of the magnet bobbin.

I have a 1-h.p., 10 ampere, arc machine which I wish to change to an incandescent machine. How may this be done? M. M.

Count the turns on the field, which, multiplied by the series amperes, will give the ampere turns, of which take, say, 80 per cent. for an incandescent machine. As a 10-amp., 50-volt machine, the shunt winding may take 1 amp. or less, and its resistance will, therefore, be 50 ohms or more. Select a wire such that with the necessary turns the resistance will be that determined as above, changing the shunt current if the resistance does not come out right on the first calculation.

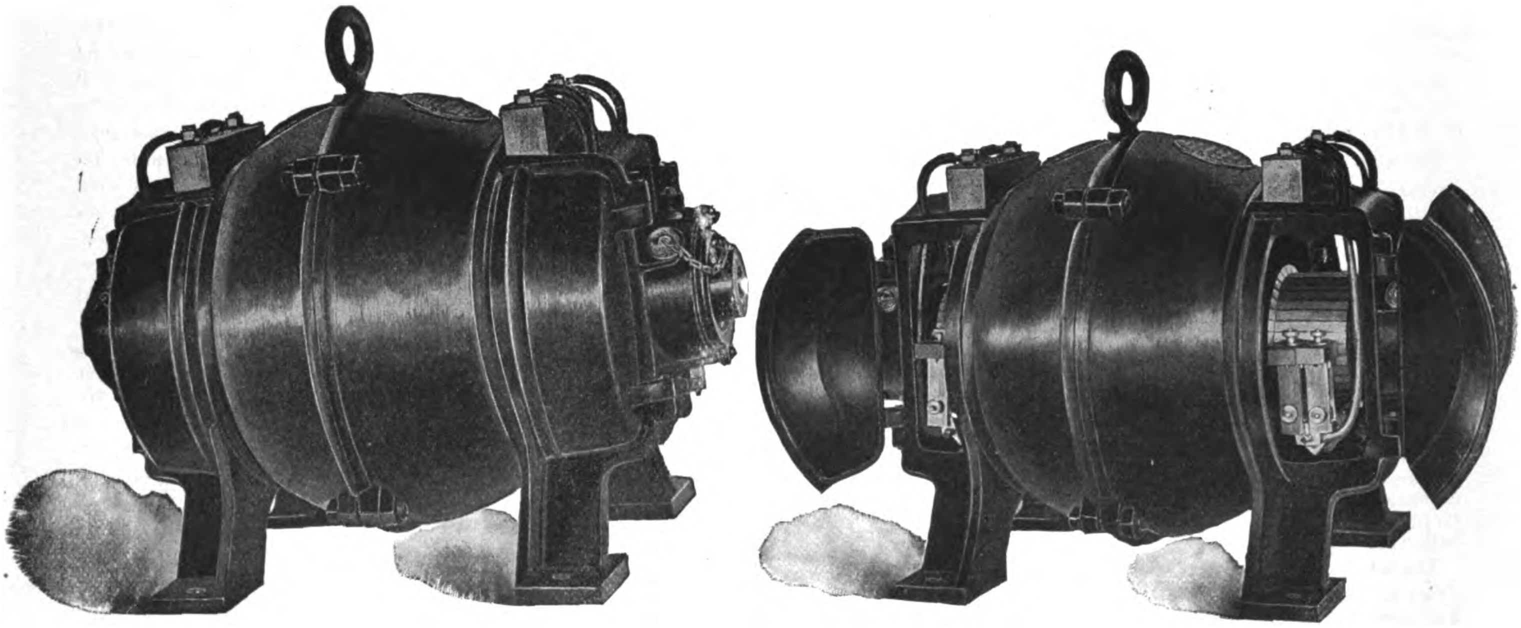
I find an abnormal drop in a line of No. 6 wire feeding a group of lamps in a mill several hundred feet from a transformer. What can be done to lessen this drop, which is probably due to inductance? R. A. L.

Run two circuits of No. 9 wire some distance apart, which will halve the inductive drop, or the No. 6 wire may be retained and another line of No. 9 wire run, in which case it may be well to put a non-inductive resistance in the larger line to bring its resistance up to that of the smaller. The reason for the resistance is that, as the inductive drop is due to the current, this should be reduced in the larger line to get the full benefit of the second line.

NEW APPARATUS AND APPLIANCES.

SPHERICAL BI-POLAR MOTORS.

The accompanying cuts illustrate a new line of bi-polar machines now being placed upon the market which, from their appearance, are called the spherical or round type. The machine shown is a new motor-generator and is represented with open and closed trap door.



SPHERICAL BI-POLAR LUNDELL MOTOR.

The new motor is designed to meet the requirements for the rapid widening field and demand for electric motors suitable for all lines of power used. These motors are particularly adapted for direct connection to exhaust and ventilating fans, blowers for forced draft for steamships, for pumps, automobile vehicles, etc., and range in size from ¼ to 10 h.p., and in speed from 1000 r.p.m. in the larger, to 1500 r.p.m. in the smaller sizes.

The chief characteristics are embodied in the construction of the field magnets, whereby a single energizing coil magnetizes all the pole pieces, a strong protective shell for the windings of both field and armature completing the magnetic circuit. A feature of the design is that the pole pieces are magnetized directly, and the leakage of the magnetic line of force is reduced to a minimum, thereby resulting in considerable economy in ampere turns.

The armature is the ironclad type having slots or curves in its periphery for holding the armature conductors; the core is well laminated, consisting as it does of thin disks of soft annealed sheet iron, the irons having the highest magnetic permeability. The slots are insulated, and there is also a special insulation between conductors embedded in the same slot having a considerable difference of potential.

The field frame is of cast steel and the detachable end brackets shown are of cast iron. When a dust proof or any entirely closed machine is required, the trap doors on the commutator and brackets are solid iron; screened doors are used where there is an absence of dust or flying dirt, or where a high degree of ventilation is required. Carbon brushes are used, and an adjustable tension is provided, the tension spring, however, not carrying any current. The bearings are self-oiling and self-aligning. The commutator bars, which are of hard drawn copper, have such dimensions as to permit the use of carbon brushes of ample capacity, the current density never exceeding 20 amps. per square inch of contact surface.

The new type of Lundell motor above described is made by the Sprague Electric Company, 20 Broad Street, New York.

HELENA, MONT., TRANSMISSION PLANT.

A third water-power electrical transmission plant has recently been installed along the short length of the Missouri River which flows through Montana—that at Helena, situated between the Butte and Great Falls transmission plants. The effective head here is 32 ft., and the minimum continuous power available is 7000 h.p.

In the power house at present there are four pairs of turbines and four generators, but the building is designed for ten generating units. Each unit consists of a pair of 42-in. special new American turbines of 960 h.p. per pair, direct-connected to a Westinghouse 650-k.w. two-phase generator. The current will be generated as two-phase at 500 volts and a frequency of 60, and then stepped up by oil phasing transformers to 11,500 volts, three-phase, for

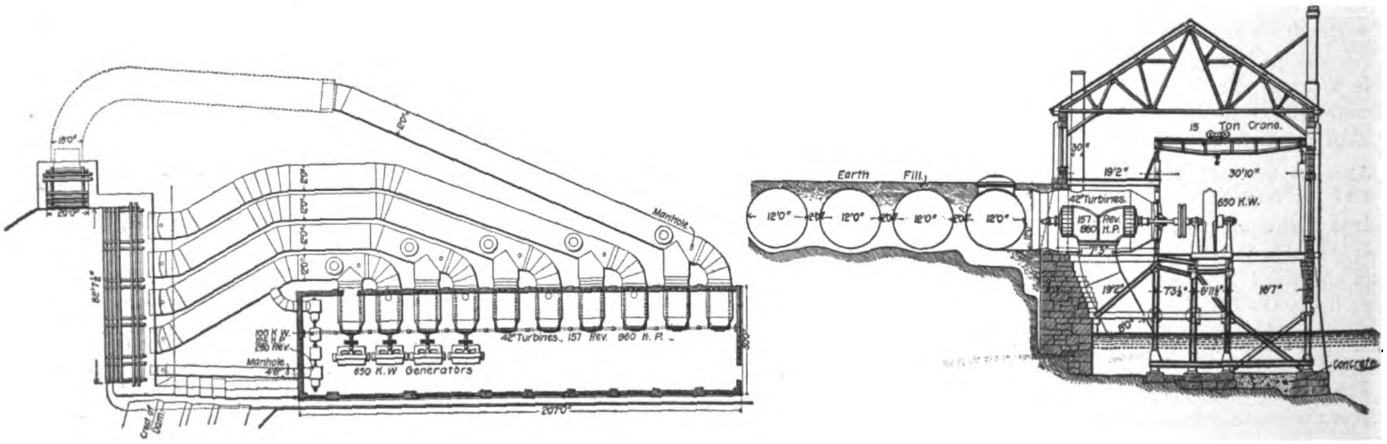


FIG. 1.—PLANT AND CROSS-SECTIONAL VIEW OF HELENA PLANT.

transmission from the power house at Cañon Ferry to Helena, a distance of 18 miles, where the current will be stepped down and transformed to two-phase current for distribution at a voltage of 1000 and 2000.

A plan and cross sectional view of the plant is shown in Fig. 1. Fig. 2 shows four of the turbines in place, and Fig. 3 gives an enlarged view of the first two turbines installed.

The turbines are placed horizontally and on cast iron double quarter-turn draft chests. Each of the draft chests, with wheels, is inclosed in a flume 12 ft. in diameter, 21 ft. 4 ins. long, and made of 5-16-in. tank steel; one end of the flume has a cast iron head and the other end is riveted to a cone connection leading to the steel supply pipe which furnishes water to the wheels.

These large flumes are mounted on bases made of steel I beams firmly bolted together with cross ties. The wheels are supplied with safety steps to prevent end thrust, and the cast iron flume heads have combined follower and stuffing boxes attached. There are also follower boxes supported by columns which carry the other ends of the wheel shaft. The shafting is in two sections, one of which is 6½ ins. in diameter and the other 8 ins. in diameter, the two sections being coupled together by means of a pair of large compression couplings inside the draft shaft. The 8-inch shaft transmits the power of both wheels to the generators through a flexible coupling.

The discharge from the turbines passes through 8-ft. draft tubes which are curved outwardly and are 16 ft. long, being made of ¼-in. tank steel. The speed of each pair of wheels is regulated by means of a Replogle governor. Each unit is guaranteed to develop 960 h.p. under 28 ft. actual working head at a speed of 162 r.p.m. In addition to the four pairs of 42-in. wheels, there are two single 25-in. special new American turbines for driving the exciters. These wheels are encased in horizontal iron flumes and discharge outwardly through a cast iron quarter-turn attached to the flume heads. The steel feed pipe which conducts the water from the dam to the flume is 12 ins. in diameter and about 200 ft. long.

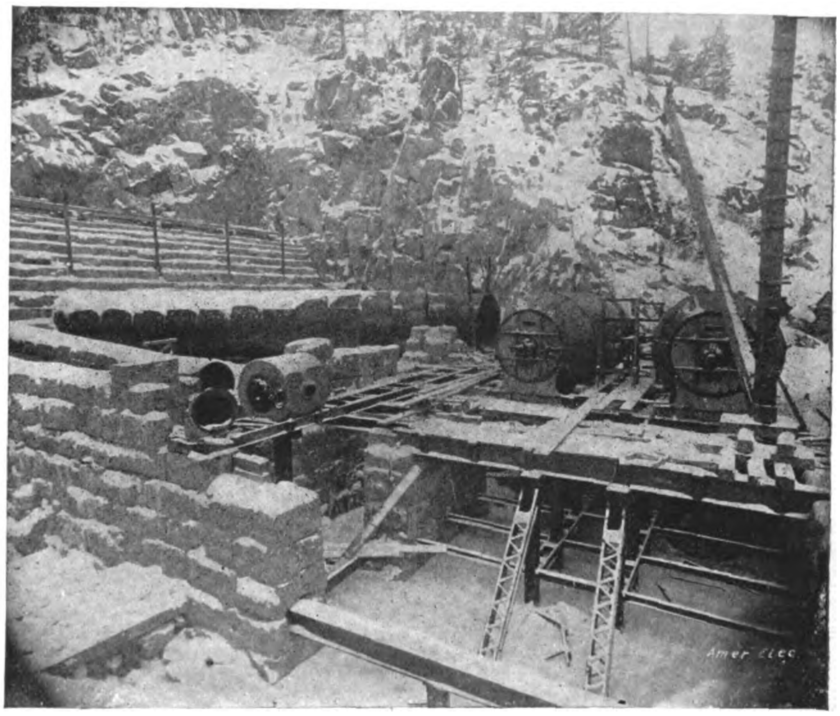


FIG. 2.—SHOWING FLUME AND TURBINES.

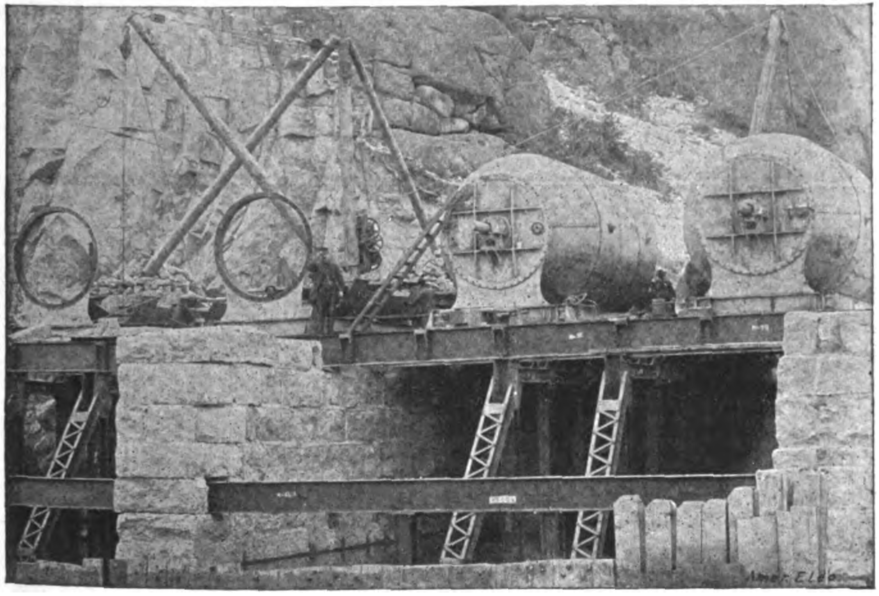


FIG. 3.—TWO OF THE TURBINES.

The new American turbines herein described were made by the Dayton Globe Iron Works Company, Dayton, Ohio

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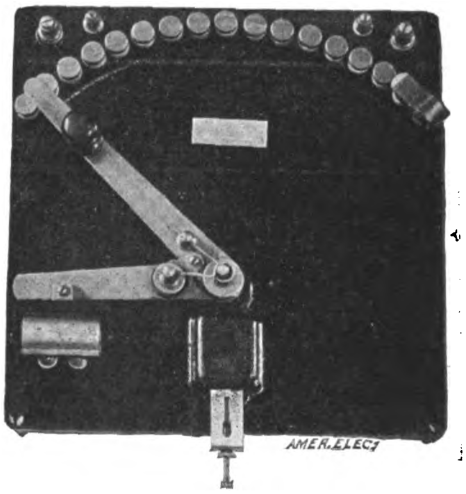
AUTOMATIC RHEOSTAT.

We illustrate herewith a recent type of automatic rheostat for motors of about 20 h.p. The rheostat has two levers, an operating lever for manipulating the rheostat and an automatic switch lever; as shown, the arm is in its starting position.

With this rheostat the circuit can only be closed when all the resistance is in circuit with the motor. A magnet connected across the main circuit holds the automatic switch lever closed under normal conditions. If the voltage falls, the holding magnet loses its magnetism and the automatic switch lever rapidly opens the circuit, being actuated by the coiled spring shown at the center of the rheostat.

A solenoid magnet, the core of which is attracted vertically against the action of gravity, furnishes the overload safety device. In case, during the acceleration of the motor or after it is running at full speed, the current exceeds a predetermined maximum amount, the plunger of the overload magnet is drawn up by magnetism and finally delivers a blow which opens a double pole switch in the circuit of the shunt magnet holding the automatic switch lever. The switch lever, being thus released, is caused by the coiled spring to rapidly open the main circuit, the final break occurring upon renewable carbon contacts. It will be observed that in order to again close the circuit, the operator must first insert all the resistance of the rheostat.



AUTOMATIC RHEOSTAT.

The overload magnet has a wide range of adjustment and is both positive and simple in its action, and cannot by any misuse be altered as to its calibration.

The Ward Leonard Company, the manufacturers of the above rheostat, has been for several years past slowly but surely perfecting this type of rheostat. The recent improvements have been in the direction of cheapening the cost of production and in making the instrument "fool proof."

OUTLET AND JUNCTION BOX.

The accompanying illustrations show a new type of outlet and junction boxes, which are so constructed as to have at frequent intervals on the surface thin webs or films which a slight blow of a hammer will knock out, leaving round holes for outlets in as many combinations as are generally required. The method of attaching the box to the conduit is new, a hollow bushel or nipple being used, which is threaded on the exterior and insulated with enamel on the interior; the nipple passes through the hole made in the box at the point desired and is screwed into a coupling at the end of the conduit, thus making a perfect mechanical connection, which may be made water-tight if desired. This type of box can be instantly disconnected from the conduit by unscrewing the nipples from the inside of the box, regardless of the number of conduits that enter it.

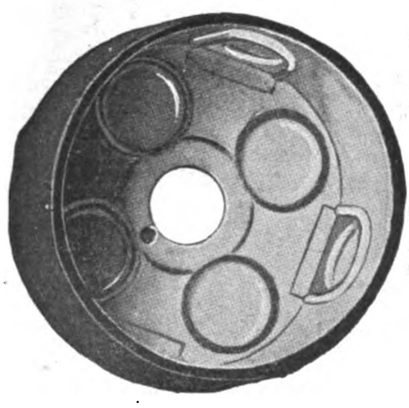


FIG. 1—CEILING OUTLET BOX.

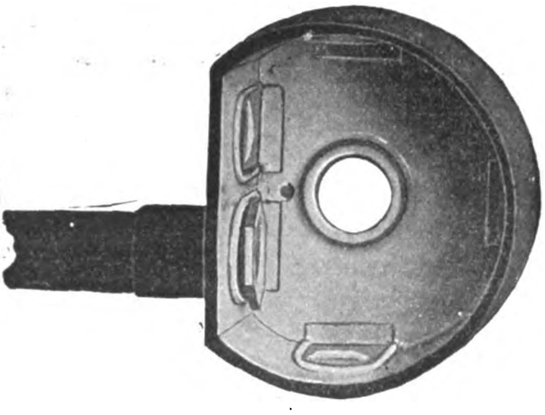


FIG. 2.—WALL BOX.

Fig. 1 shows a ceiling outlet box, which may be used for outlets where the conduits enter from the side or back of the box. The hole shown in the center acts as a support for the fixture, or for the entrance of a gas nipple if used in combination work; for straight electrical work this hole may be also used for a wall outlet.

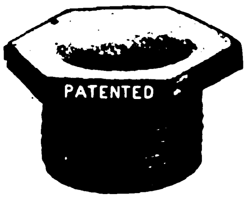


FIG. 3.—NIPPLE.

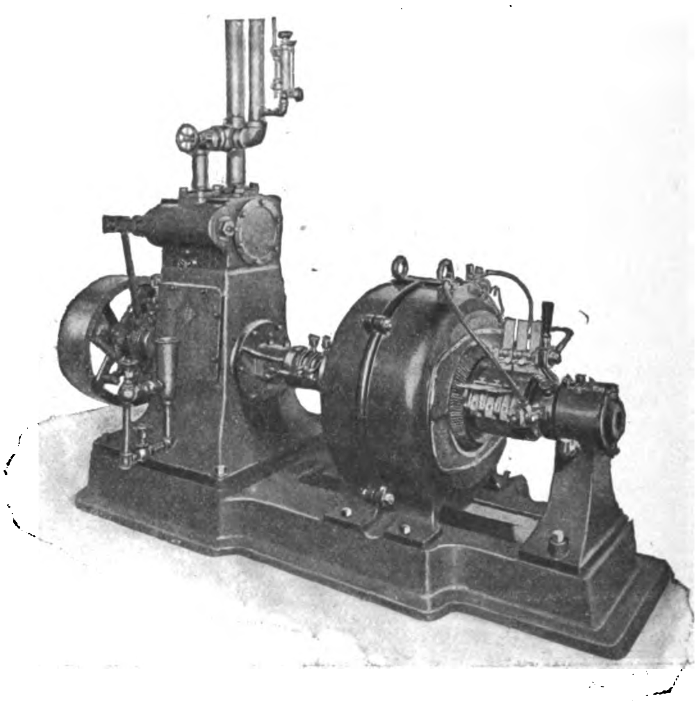
Fig. 2 is designed for a wall box where two conduits enter both on the same side; this box can also be used as a ceiling box when outlets come on the bottom of iron beams.

The nipple used with this fitting is shown in Fig. 3. As will be seen, it is made with a hexagon head, which allows it to be easily screwed into a coupling or on the end of a conduit; the nipple is painted with a special hard dry enamel that adheres firmly and will not chip off. In drawing in, this type of nipple is of special advantage, as it prevents abrasion and enables wires to be drawn in with much ease.

The above described fittings are made by L. A. Chase & Company, 161 Ft. Hill Square, Boston, Mass.

MARINE ELECTRIC LIGHTING.

The accompanying illustration shows an electric generating marine unit, two of which have been installed on the steamer Juniata, formerly the Merchants and Miners' Line, but now in the service of the Navy as a floating machine shop. The set consists of a Case high-speed automatic engine, direct-connected with a Lundell dynamo, and while capable of supplying 250 16-c.p. lamps, it takes up no more room than an ordinary roll-top desk.


MARINE GENERATING SET.

Aside from the compactness and light weight of this outfit—two extremely important qualifications in apparatus for use aboard ship—the Case engine possesses a number of features rendering it especially desirable for marine work. One of these consists of oil retaining devices by means of which the lubrication is not affected in a sea way. Another is the use of thrust bearings, which hold the crank and armature securely, thus taking care of unusual strains upon the bearings arising from the ship's motion.

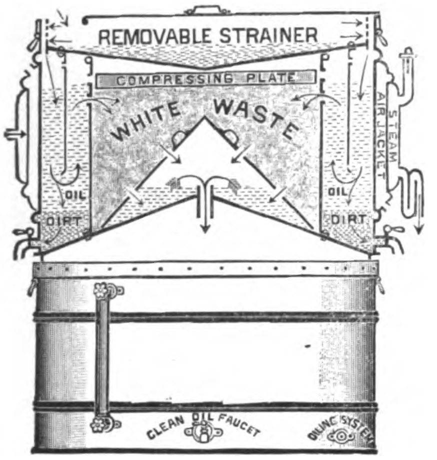
The above outfit is made by the New Britain Machine Company, New Britain, Conn.

OIL FILTER AND PURIFIER.

The main feature of the oil filter shown in the accompanying illustration lies in the initial heating of the oil to be filtered by means of exhaust or live steam, which is admitted into a steam jacket surrounding the upper part of the casing, but separated from the inner surface by an air chamber.

The dirty or waste oil is poured into the strainer shown, which retains all the grosser impurities; the oil then passes very slowly through a large area of fine straining surface; then downward toward the bottom of the straining and refining chamber, the oil being kept away from the filtering material by a deflecting shield. The annular settling and refining chamber is always filled with heated oil, which is almost completely purified before it overflows into the central filtering chamber. In the latter, it gradually filters through a large area of compressed filtering material, passing finally through a muslin cover over a perforated central cone, this cone presenting a large area of filtering surface.

As stated in the opening paragraph, in the refining and settling chamber the oil is heated through the medium of air within a jacket interposed between the steam jacket and the annular filtering space. The heat thus applied thins the oil, makes it bright and clear, all of the entrained water and heavier impurities being quickly separated and precipitated to the bottom of the chamber, whence they are readily drawn through faucets. Any desired temperature, from 140 to 180 degs., may be thus applied to the oil. One of the advantages of this method of heating oil is that the temperature can be very exactly regulated by simply screwing large or small bushings into the outlets of the air jacket, and at no time is the oil exposed to a temperature more than a few degrees above the normal temperature desired. The purified oil accumulates in the bottom tank and is delivered cold at the clean oil faucet.



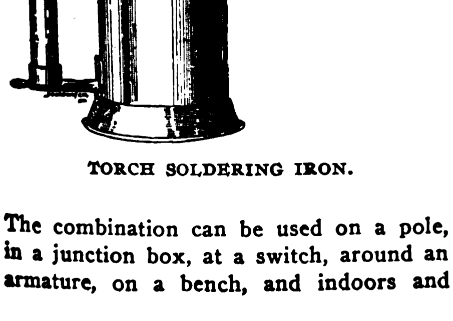
OIL FILTER AND PURIFIER.

The compressing plate shown in the illustration maintains a uniform pressure on the filtering material, thus making it compact and insuring good work. By simply lifting off this plate, the filtering material may be inspected or removed without drawing off any oil or disturbing any part of the apparatus.

The oil filter described, known as the "Famous Oil Filter," is made by the Famous Filter Company, St. Louis, Mo.

SOLDERING IRON.

The accompanying illustration shows a soldering iron which may be very simply attached to the ordinary blow torch. As will be seen, it is only necessary to slide a ring through the blow torch tube and tighten it with a screw. By means of this attachment a connection can be soldered without burning the insulation on the wire. The combination can be used on a pole, in a junction box, at a switch, around an armature, on a bench, and indoors and outdoors without danger of blowing out in the latter case.



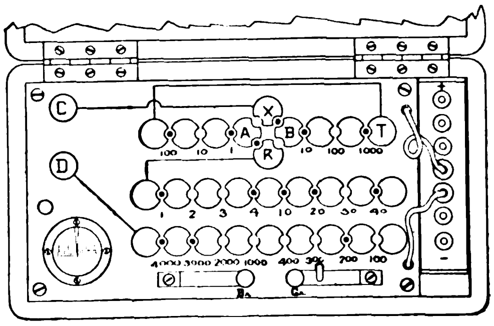
TORCH SOLDERING IRON.

This attachment is made by the Electric Supply Company, 232 King Street, Madison, Wis.

PORTABLE TESTING SET.

The "Jagabi" portable testing set, recently placed on the market, is claimed by the makers to be the simplest, lightest in weight and most compact instrument of its class which has yet been made. It has outside dimensions, 9½ ins. x 5 ins. x 4 ins., and weighs about 7 lbs. The apparatus comprises a highly sensitive D'Arsonval galvanometer, Wheatstone bridge, rheostat, silver chloride battery, and keys for both galvanometer and battery, all mounted in a handsomely finished mahogany case with lock and handle. This combination forms a remarkably convenient piece of apparatus for use in making all classes of resistance measurements that come within its range.

The general scheme of arranging the different parts is shown in Fig. 1. From this it will appear that the rheostat has sixteen coils, ranging from 1 to 4000 ohms, and having a total capacity of 11,110 ohms. The bridge arms are 1, 10 and 100 ohms on one side, and 10, 100 and 1000 ohms on the other side. A unique reversing device enables the same result to be obtained with the bridge as if four pairs of coils were on each side. Six cells of chloride of silver battery are provided, these being sufficient for all ordinary requirements. When specially high resistances are to be measured, an outside battery of greater capacity should be used. An important improvement to be noted in connection with the galvanometer is a small exterior milled head screw, by means of which the zero may be adjusted in case of any small change of tension in the spring. This feature will be much appreciated by those familiar with testing sets already on the market.



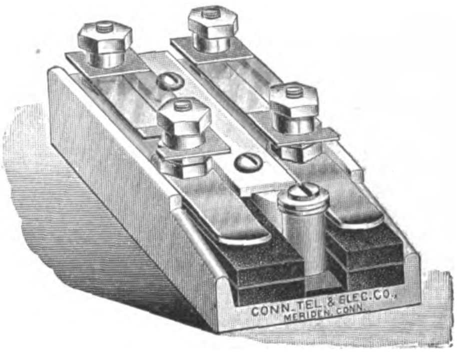
PORTABLE TESTING SET.

The apparatus is so arranged that the rheostat coils may be used by themselves; the galvanometer may be used independently; the galvanometer and battery connected in series may be used without the rheostat and bridge; or, the galvanometer, battery and rheostat may be connected in series. Thus every possible combination is provided, so that, practically speaking, each distinctive part of the set may be used alone, or in connection with the other parts, as desired. By means of traveling plugs, any coil, or group of coils may be isolated or used for a derived circuit. By a simple arrangement of the plugs the set may be used to measure high insulation by the direct deflection method.

The Jagabi portable testing set is manufactured by Elmer G. Willyoung & Company, Philadelphia, for which firm James G. Biddle, 910 Drexel Building, Philadelphia, is sole selling agent.

LIGHTNING AND SNEAK CURRENT ARRESTER

The accompanying illustration shows a device for protecting switchboards or instruments from lightning discharges and sneak currents. The protection is double, consisting of a fuse and a spark gap. The fuse link consists of a piece of mica with metallic terminals, the two latter being connected by a fusible wire of small cross-section, the wire being held firmly in place against the mica by shellac. The spark gap is made up of two pieces of carbon separated by a piece of mica in which several holes are punched.


CONN. TEL. & ELEC. CO.
MERIDEN, CONN.

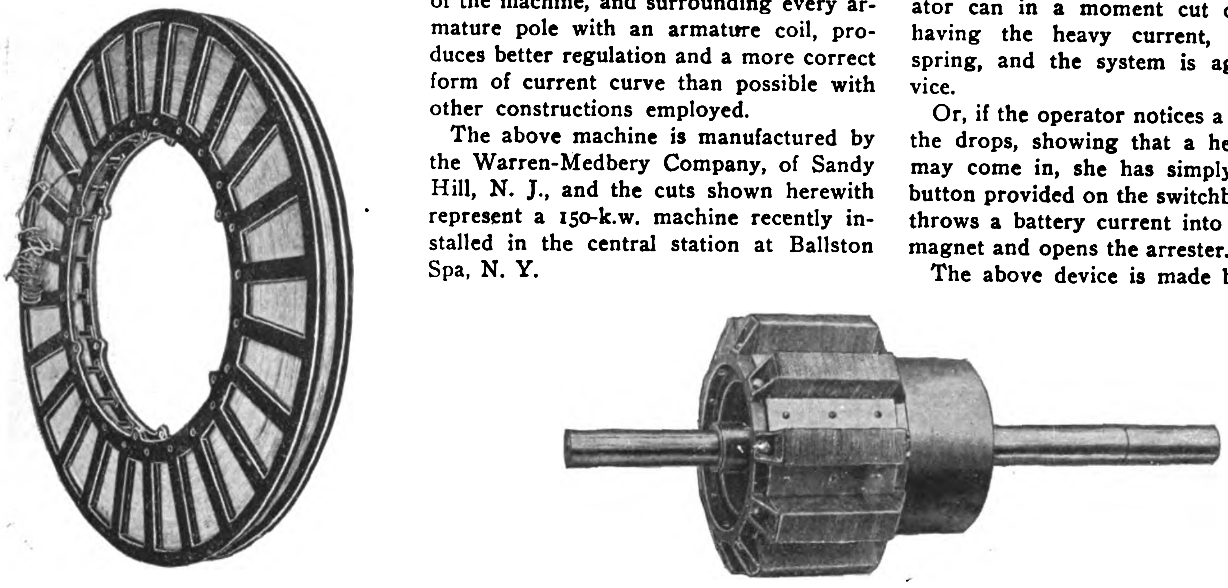
LIGHTNING AND SNEAK CURRENT ARRESTER

The mechanical details of the block are very efficient. The fuse link may be very quickly renewed, not differing in this respect from the ordinary metallic clip link. The spark gap carbons are held in place by two projecting springs, as shown in the cut, and for renewal or examination they are merely slid from under the springs. The Connecticut Telephone and Electric Company, Meriden, Conn., are the manufacturers.

INDUCTOR ALTERNATOR.

In the improved type of inductor alternator shown in the accompanying illustrations, the utmost attention has been given to the perfection of both mechanical and electrical details. The lower half of the frame, including supports for bearings, constitute a single casting, thus insuring great strength, rigidity and proper alignment. The bearing sleeves are made solid and have a large surface, which is lined with anti-friction metal. The bearings are self-oiling and their supports so designed that when it is desired to remove a sleeve, the only operation is the removal of the cap, after which the sleeve may be slipped off endwise of the shaft.

By the removal of two frame bolts the upper half of the frame which carries the upper half of the armature and corresponding armature coils, may be lifted off. The revolving inductor is surrounded at the small end by a field coil, which latter is attached to an annular yoke casting. The armature body is made of soft steel and the armature is built up of very thin sheets of metal, served on both sides with an insulating compound to prevent the formation of eddy currents, and there is a series of internal recesses which admit of a free circulation of air entirely around the armature.



FIGS. 1 AND 2.—ARMATURE AND INDUCTOR.

The armature coils are machine wound and thoroughly saturated with an insulating compound, being retained in shape by a single layer of tape covered with waterproofing compound. The insulation of the coils is mainly obtained from a special insulating trough forming the interior lining of the coil slots in the armature. For 1000 or 2000-volt armatures these troughs are subjected to a break-down test of 6000 volts. After the troughs and coils are in place in the armature, an insulated and perforated cover closes up the coil slot, and the revolving inductor causes a current of air to flow continuously around the coils.

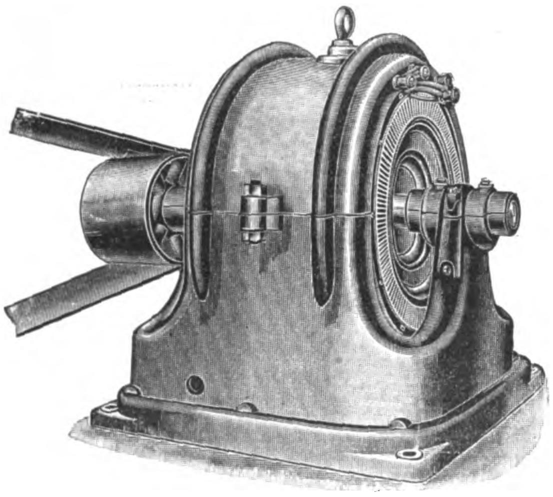


FIG. 3.—INDUCTOR ALTERNATOR.

The field coil case consists of two ring castings spaced by means of rods of insulating material, the sides being lined at numerous places with narrow strips of insulating material. The wire is wound over the insulating rods in such a manner as to leave exposed the outer and inner circumferences of the coil and practically both sides, thus insuring efficient ventilation. It is claimed that the placing of all the armature coils in a single wreath at one end of the machine, and surrounding every armature pole with an armature coil, produces better regulation and a more correct form of current curve than possible with other constructions employed.

The above machine is manufactured by the Warren-Medbery Company, of Sandy Hill, N. J., and the cuts shown herewith represent a 150-k.w. machine recently installed in the central station at Ballston Spa, N. Y.

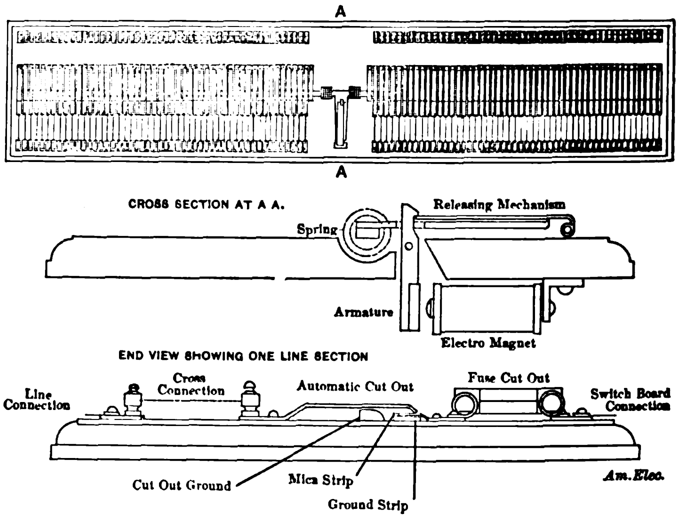
AUTOMATIC LIGHTNING ARRESTER FOR TELEPHONE EXCHANGES.

The accompanying cut shows the details of a new type of lightning arrester, the one illustrated being for 100 lines. Connection to the line is made from the binding posts shown in the lower cut, and from the latter the connection is along the automatic spring, over a ground strip insulated from the spring through a ¼-amp. fuse to the switchboard.

When a heavy current comes on any line, it seeks, of course, a ground through the path of least resistance, and in passing over the tension spring, finds an outlet to the ground strip, which is insulated from the line spring by a thin piece of perforated mica. In following this ground strip it is conducted through the electro-magnet shown in the middle cut, which, being thus magnetized, releases the spring, throwing open all the cut outs on the board through the cut-out ground strip being raised by the action of the springs. All the lines are then grounded, and the switchboard operator can in a moment cut out the line having the heavy current, replace the spring, and the system is again in service.

Or, if the operator notices a fluttering of the drops, showing that a heavy current may come in, she has simply to push a button provided on the switchboard, which throws a battery current into the electro-magnet and opens the arrester.

The above device is made by the Keystone Telephone Company, 565 Old Ave., Pittsburg, Pa.

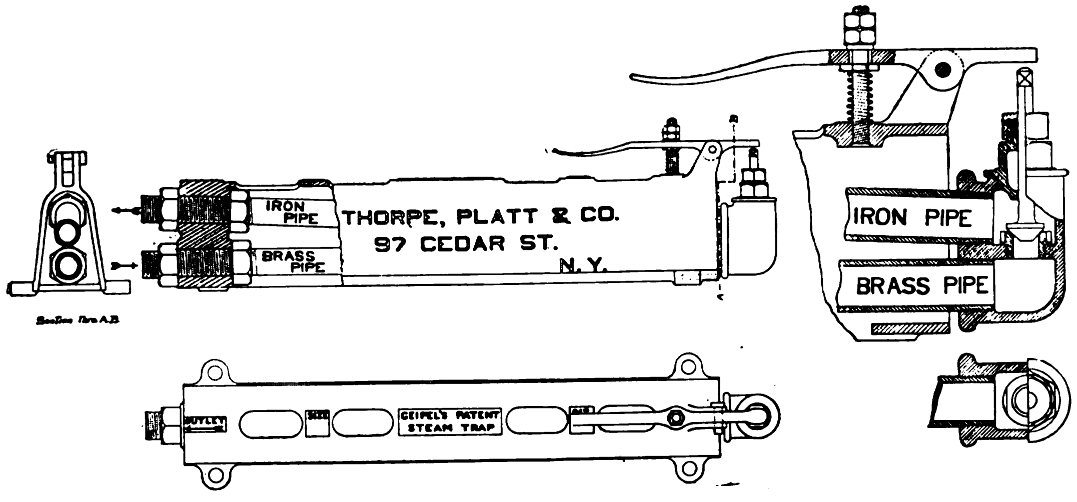


AUTOMATIC LIGHTNING ARRESTER.

AUTOMATIC DRAIN COCK.

The steam trap or automatic drain cock shown herewith utilizes the expansion principle in its working, the motion of expansion being, by the simple arrangement adopted, multiplied many times.

Referring to the illustration, the lower or brass pipe is connected to the steam pipe, the upper or iron pipe forming the discharge. These two pipes form the two sides of an isosceles triangle, the valve seat being at the apex. The valve spindle butts against the lever. When cold, the brass pipe is contracted, the apex is drawn down so that the valve is fully open, and the water is discharged. As soon as steam enters the brass pipe, the latter expands and raises the apex, when the valve is closed. In order that the valve may be set to blow off at any pressure desired, a screw adjustment is provided. In addition to this, when it is desired to "blow through," the valve may be opened by hand by merely pressing the lever. The valve may be readily examined by unscrewing the top; this is a desideratum, as it is a common occurrence for the valves in all steam traps to become choked with sediment or to require attention otherwise; it is claimed that this trap can be taken apart and put together again in five minutes.



STEAM TRAP.

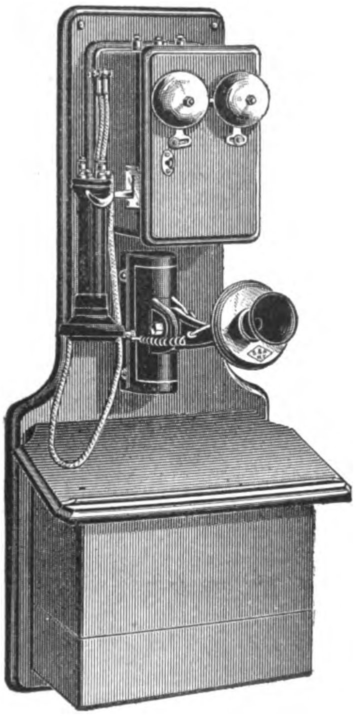


FIG. 1.—LONG DISTANCE WALL TELEPHONE.

The inventor of this trap is Mr. William Geipel, a well known English electrical engineer, and one of the authors of Geipel & Kilgour's "Electrical Engineering Formulae." The American manufacturers are Thorpe, Platt & Company, 97 Cedar Street, New York.

LONG DISTANCE TELEPHONE.

The telephones shown herewith have been especially designed to meet the requirements of both general exchange and long distance work. The transmitter contains a diamond grain carbon, imported by the makers and prepared by them for use after a secret process. A 10,000-ohm generator is used with these sets and two cells of Stanley battery. The switch is of the long lever type, with rubbing contact and German silver springs. All contacts have platinum points, thus obviating any trouble from corrosion. The compound magnets used in the receivers are magnetized with great care, and the lifting power of each magnet carefully tested before assembling. The bobbin is wound with silk wire and tested to a standard of resistances. Fig. 1 shows a wall set and Fig. 2 shows a desk set of the same type of apparatus, which is made by Stanley & Patterson, 32 Frankfort Street, New York.

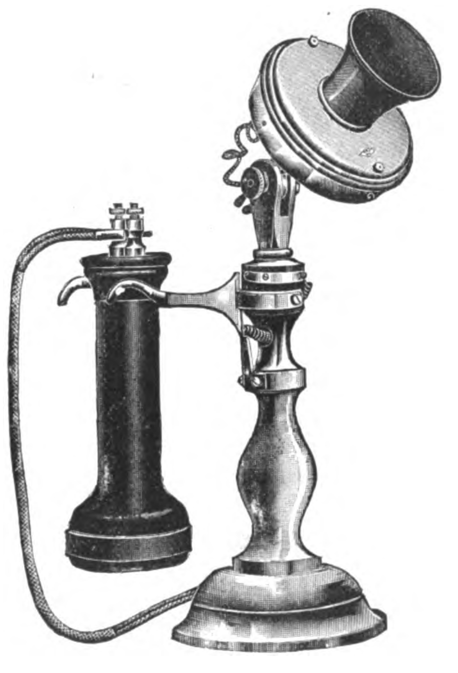
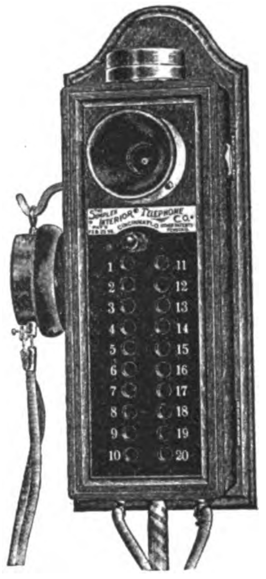


FIG. 2.—LONG DISTANCE DESK TELEPHONE.

INTERCOMMUNICATING TELEPHONE.

The twenty-station intercommunicating telephone set shown herewith is of a type intended for factories, stores, warehouses, institutions, etc. By its means communication may be had between any two telephones, and any number of pairs may hold conversation at the same time without interference, thus obviating the necessity of a central exchange. But one set of batteries is used. The manufacturers are the Simplex Interior Telephone Company, Cincinnati, Ohio.



SIMPLEX TELEPHONE.

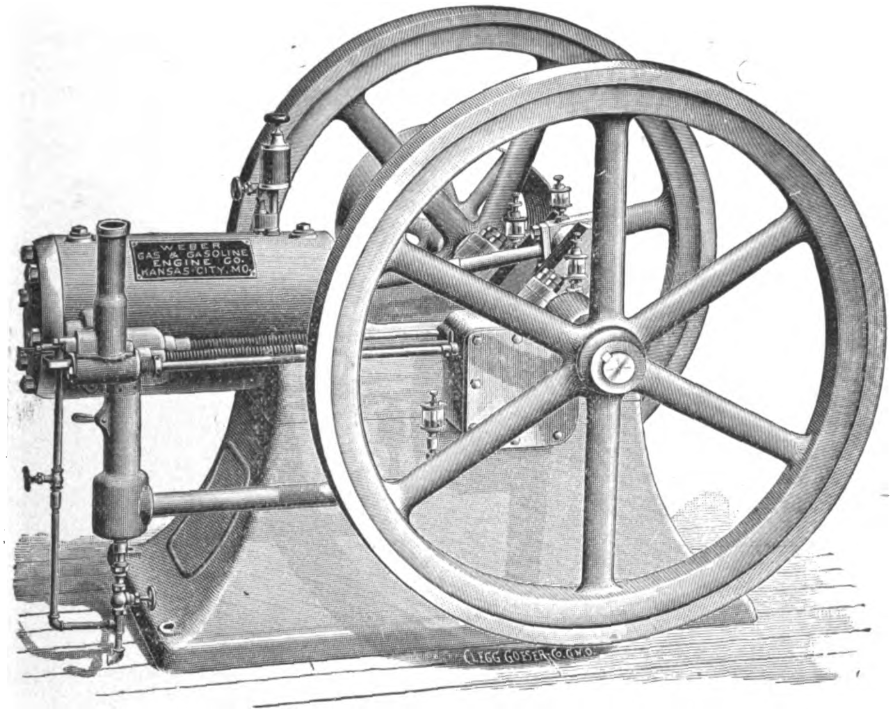
THE WEBER GAS ENGINE.

In the Weber gas engine, shown herewith, the latest mechanical improvements in machinery construction have been introduced. The wearing parts are made interchangeable, and the valve seats are separate castings, so that they may be cheaply renewed when worn. The valves are located so as to render them easy of access for examination or regrinding and, together with the valve chambers, are kept from becoming overheated by water around the seats.

The valve gear is incased in an iron housing, dust and grit proof, and the gears run constantly in oil. The governor regulates so that the engine receives only so much of the charge as is needed to do the work; when on light load, only as many charges are admitted and ignited as are needed to keep up the speed of the engine, which speed can be instantly changed while in motion. This type of engine is fitted with the incandescent tube igniter.

The makers claim that this is the only type of gas engine in which the point of gas ignition may be altered while in operation, which effects not only a saving in fuel, but prevents the engine from starting backward.

The pistons are of unusual length, and instead of being packed with ordinary snap rings, packing rings are employed made up in sections with a German silver spring behind each section, which forces the rings



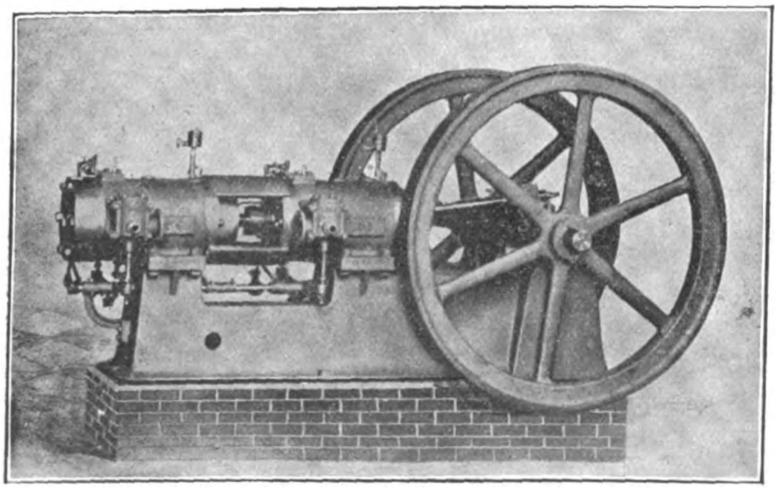
WEBER
GAS & GASOLINE
ENGINE CO.
KANSAS CITY, MO.

WEBER GAS ENGINE.

against the walls of the cylinder at all times, thus taking up the wear, however slight it may be; by this means, it is claimed that the springs can be used until they are worn down to an extreme thinness.

The gas engine described is made by the Weber Gas and Gasoline Engine Company, Kansas City, Mo.

FRONTIER GAS ENGINE.



FRONTIER GAS ENGINE.

In the gas engine shown herewith there are two single-acting cylinders placed tandem, each cylinder operating alternately on the four-cycle principle, which arrangement secures an impulse every revolution instead of every second revolution, as in the usual single-cylinder engine. The impulse is consequently only about one-half as great as in the case of the one-cylinder engine of the same power, and the resulting strains are, of course, reduced in the same proportion.

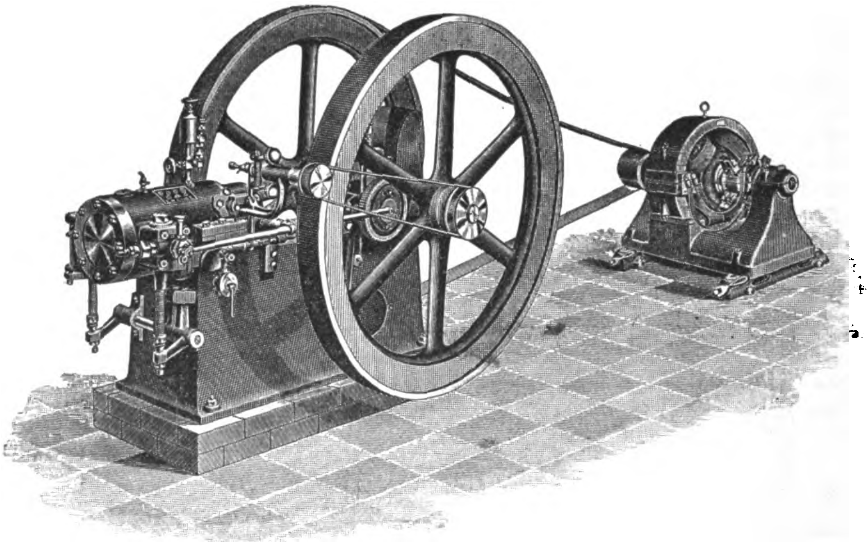
The type of governor used operates the throttle valve and regulates the amount of gas or gasoline required in almost direct ratio to the power used under varying loads. The speed may be readily changed by adjusting the governor, and the point of ignition is varied at will when the engine is running. Electric spark ignition is used exclusively on this type of engine, the igniting device being both simple and accessible. Engines of 25 h.p. and under are quickly and readily started by hand. Above this size pneumatic self-starting appliances are fitted.

A special claim for this type of engine is in the use of but one crank, one connecting rod and one piston rod, thus reducing the principal moving parts to a minimum. The vertical valves have positive motion as well as the gas feed, and while this adds to the number of smaller parts, the advantages are obtained of superior efficiency and economy.

All the valves as well as cylinders and cylinder heads are water-jacketed. The gears are cut from solid blanks and no bevel gears are used. The crank shaft bearings are so designed that the thrust is against the bearing itself and not on the caps. The engine may be readily changed from gas to gasoline, or vice versa.

We understand that a number of these engines, which are made by the Frontier Iron Works, Detroit, Mich., are in operation running electric light plants, and giving very satisfactory results.

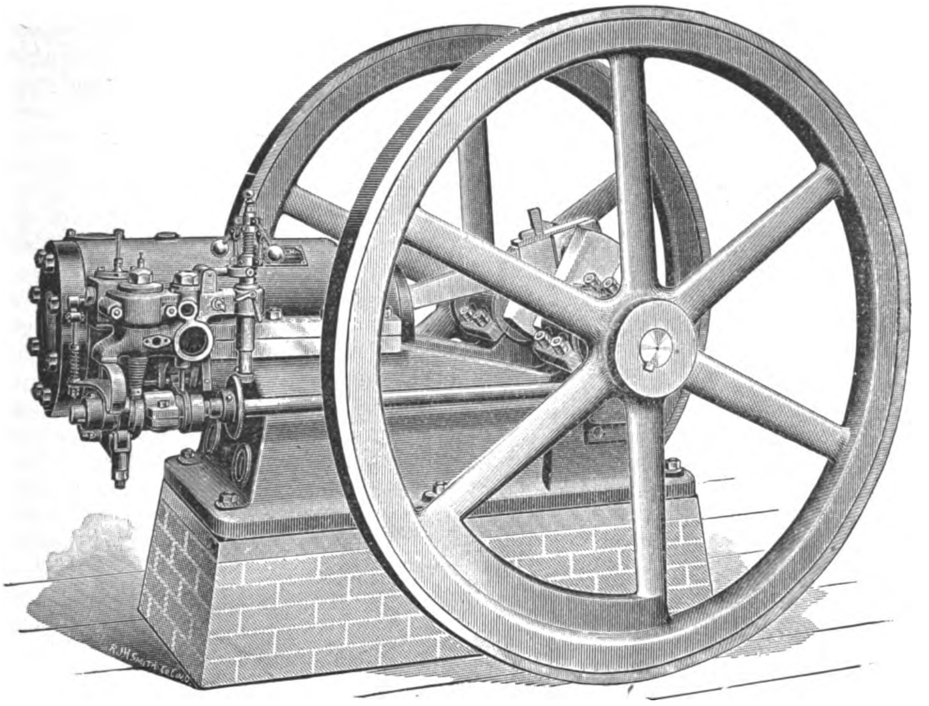
FOOS GAS ENGINE.



FOOS GAS ENGINE.

The manufacturers of the gas engine shown in the accompanying illustration state that in its design simplicity of construction was one of the points kept constantly in view, and the engine has been made to comprise as few parts as possible. The inlet and exhaust valves, as well as the igniter (which is of the electric type) require occasional cleaning, and are therefore so constructed and placed that they may be easily removed and examined. The crank shaft boxes are of phosphor bronze, and designed to insure the least amount of friction obtainable with liberal proportionate bearing surfaces. All the parts of the engine are made to carefully constructed gauges, thus making parts interchangeable. The governor is of the centrifugal type, and the speed of the engine can be increased or reduced, if desired, while it is running. The valves are positive in their operation, and are made of ample size to procure the highest efficiency without putting them to an unduly severe strain. The engine as built at present can be changed in a few moments to use either gas or gasoline.

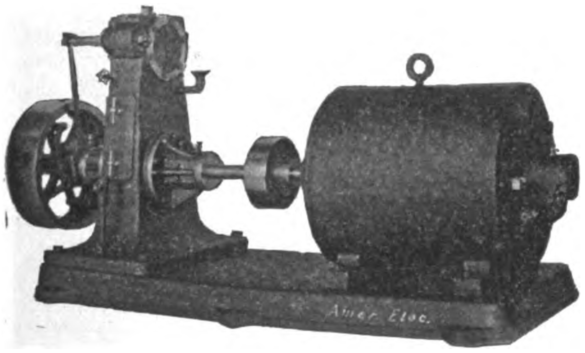
The engine shown in the illustration is specially made for electrical work, and designed to give a perfectly steady light even under partial load; and under a full or nearly full load the makers guarantee a variation not to exceed 2 per cent. The manufacturers are the Foos Gas Engine Company, Springfield, O.



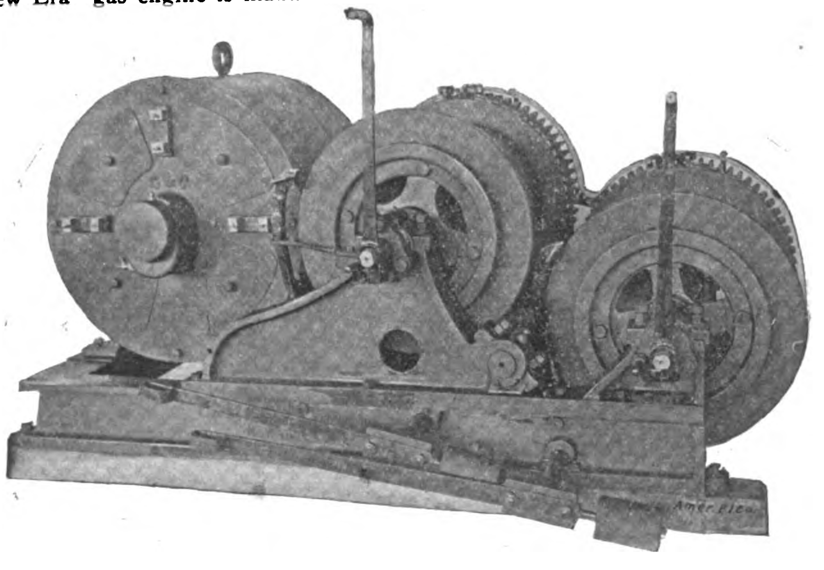
"NEW ERA" GAS ENGINE.

"NEW ERA" GAS ENGINE.

The engine shown in the accompanying illustration uses either gas or gasoline for fuel and is of the single cylinder, self-scavenging type. As will be seen by reference to the cut, the valves, igniter, governor, etc., are all arranged on one side of the engine, and operated by cams or gears on a shaft at right angles to the main shaft. The angle pillow blocks receive the shock of the explosion at the bottom, the wear being thus easily taken up. The shaft which carries the cams is run by spiral gears covered by a shield, the gears running in oil; this overcomes the noise made by the usual type of cog gears, and increases the life indefinitely.



MARINE GENERATING SET.



DOUBLE-DRUM ELECTRIC HOIST.

There is a valveless port in the seat of the cylinder, so placed that it is automatically uncovered by the piston, allowing the burned gas to escape to the exhaust vessel or pipe. The only duty for the regular valve to perform is therefore to provide for the escape of what little is left in the cylinder. This not only extends the life of the exhaust valve, but improves the efficiency of the engine. For igniting the charge, an electric igniter is recommended, though the hot tube may be employed.

The "New Era" gas engine is manufactured by the New Era Gas Engine Company, of Dayton, Ohio.

SOME NEW "C. & C." COMBINATIONS.

We illustrate herewith a new form of marine generating set recently placed upon sale by the C. & C. Electric Company, of New York, which seems to possess a great many good qualifications for the work it has been designed to perform. The set consists of a C. & C. entirely inclosed type, four-pole ironclad dynamo, directly connected to a "Case" vertical automatic engine, both mounted upon one cast iron base. Both the engine and dynamo being entirely enclosed, there is no danger of the apparatus being disabled through a drenching, to which many marine lighting plants are liable in rough weather. These sets are made in capacities of from 2½ to 12 k.w.

Another illustration shows a C. & C. electric hoist, of the double-drum type, in which the C. & C. ironclad motor is employed. The manufacturers are furnishing these hoists in either the single or double-drum type and in capacities from 5 to 50 h.p.

The company showed one of each of the above mentioned combinations in their exhibit at Madison Square Garden during the May exhibition, where they attracted very favorable notice.

SILEX INSULATED CONDUIT.

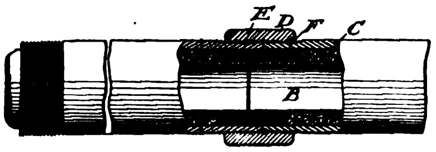
Electrical insulation can be accomplished more or less perfectly by materials which, beyond their similarity as insulators, vary to the widest extent. The qualities necessary to the ideal insulator are incombustibility, non-conduction of heat, non-conduction of shock, unchangeability, flexibility. Every insulator possesses one or more of these qualities; the mineral insulator has been held to come the nearest to the ideal, but hitherto has lacked in flexibility.

The method of insulation applied in the type of conduit shown in the accompanying illustration is claimed by the manufacturers to fulfill the idea requirements. An iron or steel outer tube is separated from an inner tube, B, of metal by finely pulverized, densely packed silex, C. Each section of the conduit has at one end a projecting and, at the other end, a receding insulating device, as shown in the accompanying illustration, at E and F.

The converse ends fit into each other when lengths of conduit are brought together with right and left screw-coupler, D, and thus form a perfect union, insuring continuous insulation and a smooth-bore raceway, free from any possible obstruction.

Silex, in its pure state, is recognized not only as possessing extremely high insulating properties, but also exceptional heat-resisting qualities, fusing only in the oxy-hydrogen flame. As used, the silex is thoroughly waterproofed.

If silex is pulverized and a little put under a microscope, it will be discovered that there are no round particles in it, all being wedge-shaped, sharp, splintery and irregular. The material, therefore, may be packed to nearly the solidity of the rock from which it was ground. It is completely unchangeable, and in being packed it so arches around the inner tube that this tube cannot change its relation to the outer tube though it may be bent to an angle of 90 degrees.

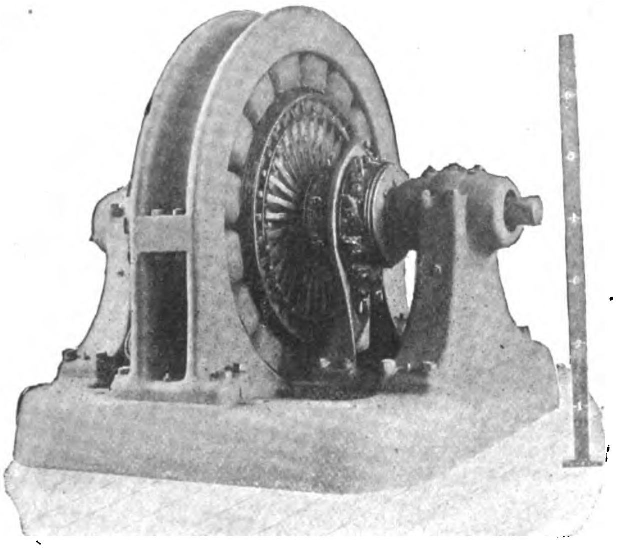


SILEX CONDUIT.

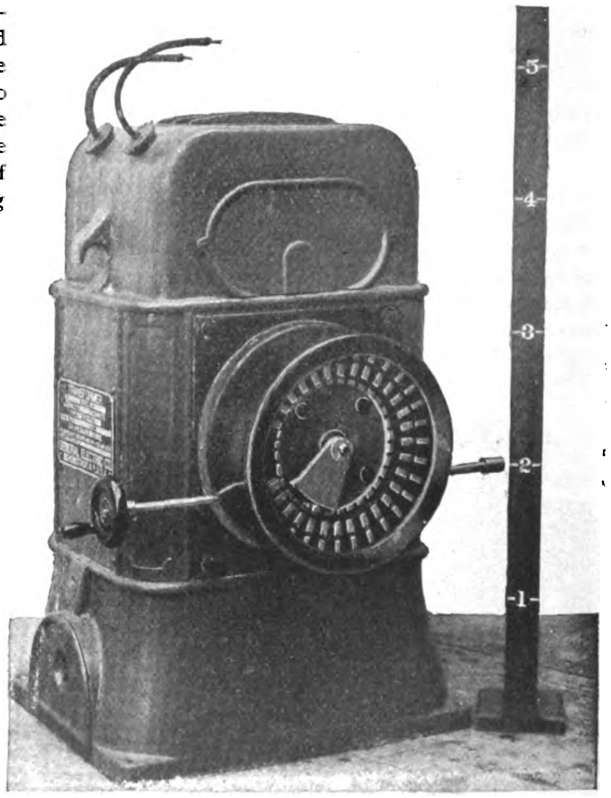
The Silex Insulation Company, 39 Cortlandt street, New York, are the manufacturers, and at their booth at the late Electrical Show, Madison Square Garden, the new conduit, above described, called "Three-eye Conduit," attracted much attention.

BATTERY TELEPHONE GENERATOR.

The machine shown herewith is designed for use in telephone exchanges, and can be operated either by a battery or from an electric lighting circuit, in the former case requiring about .3 amp. at 8 volts.

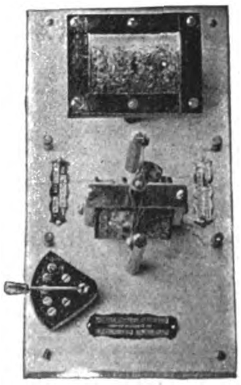


400-K. W. ROTARY CONVERTER.



220-K.W. TRANSFORMER.

Many exchanges do not have access to a lighting circuit or to any other source of power by means of which to operate a separate generator, and therefore have been compelled to use a hand ranger. To such as these a machine like that illustrated will without doubt appeal very forcibly. The manufacturers are the W. F. Warner Co., Muncie, Ind.



BATTERY TELEPHONE GENERATOR.

A LARGE ROTARY CONVERTER.

In the station of the Pennsylvania Heat, Light & Power Company, Philadelphia, Pa., has recently been installed by the General Electric Company the largest 60-cycle rotary converter yet constructed. It is a 16-pole machine, of 400 k.w. capacity, running at 450 r.p.m., and was designed to convert an alternating two-phase current of 60 cycles' frequency and voltage variable between 165 and 220 volts, into continuous current at from 225 to 300 volts. It stands 8 ft. high on a base 8 ft. 4 ins. x 8 ft. 6 ins.

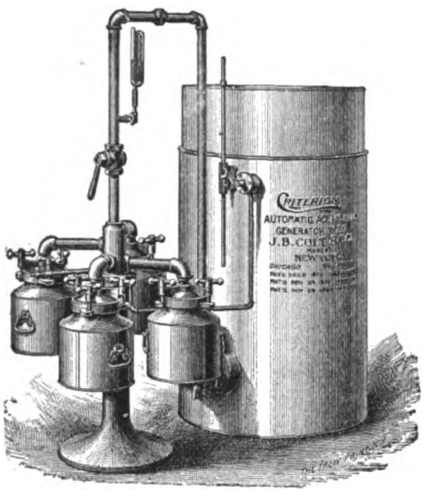
The field frame of this machine is heavily ribbed, divided horizontally and susceptible of movement along the base to allow of inspection of the armature and field coils. The bearings are extra long and of the self-oiling and self-aligning type, that at the commutator end of the shaft being provided with an end play device to keep the armature in constant motion in the direction of the length of the shaft and distribute the wear of the brushes over the commutator surface to avoid the wearing of grooves. The armature is of the iron-clad type.

To facilitate the removal of a brush for examination and replacement without varying the tension under which it runs, a brush-holder of unique design has been devised. To remove the brush the prolonged end of the brush-holder is disengaged from the brush-holder by a slight end motion. Another feature in this machine is the design of the brush-holder studs and the method of attaching them to the yoke. The former, instead of passing through insulating bushings in the yoke—as has been customary in this type of machine—is provided with a lug bored to fit down upon a radial stud held by bolts passing through the insulating bushings. To slide the brush-holder stud off, it is simply necessary to loosen the nuts on the bolts passing through the bushings. By employing this method all labor and expenditure of time usually consumed in removing the insulating bushings and washers from the brush-holder yoke to remove the stud are avoided, and the change can be effected in a very few minutes. Upon the collector rings press numerous leaf brushes, having a long contact on the rings, and a very large current carrying capacity.

To obtain the necessary variation in the continuous current of the rotary converter the General Electric Company has furnished with it two special 60-cycle transformers each of 220-k.w. capacity. These have been designed to operate with a primary potential of 2000 volts, and a secondary potential varying from 165 to 220 volts. The variation is obtained through a dial switch over which passes a contact plate cutting out or thrown in more or less turns of the primary winding and thereby varying the secondary potential. The switch is operated by a wheel handle, and the potential may be varied rapidly in either direction, the contact plate snapping from contact to contact in one direction as well as in the other. The dial switch is applied to the transformer itself instead of being a separate device, and the entire construction is singularly compact.

ACETYLENE GAS GENERATOR.

The flame of the acetylene gas burner is very small, not more than one-quarter perhaps of the ordinary five-foot per hour coal gas burners. Yet it consumes about one-half foot per hour, giving a twenty-five candle power light; ordinary gas giving sixteen candle power. The particular feature which strongly commends the new gas to householders is the ease and cheapness with which a distinct and separate plant may be introduced into any house, a type of which is illustrated herewith.



CRITERION ACETYLENE GENERATOR.

In this type of generator the carbide is separated into comparatively small portions completely isolated from each other, one portion being used at a time, the other portions being practically cut off from contact with any dampness. The generator consists of a stand for carrying the carbide-holder and a gasometer for regulating the supply of water, keeping the gas pressure constant and taking care of the surplus gas. A condenser for cooling the gas is at the base of the gasometer. The water-regulator is placed on the side of the gasometer, from which the water supply is taken, except in large generators, in which a separate water tank is used.

The carbide-holders are made in various sizes and are attached to the stand by pipes which radiate from a central upright, but each holder is on a different level from the others; four, eight or twelve of these holders, according to size, can be conveniently arranged in sets of four, one set above the other, the gasometer being of the same capacity for any number of holders of a given size. Mechanically all movements are central; there is, therefore, no chance of any parts binding and sticking, and thereby causing change of pressure in the gas, or other trouble.

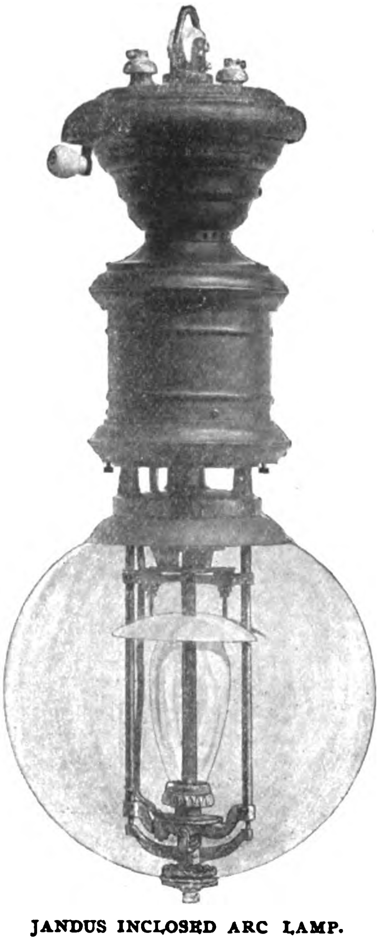
The Criterion generator above described is made by J. B. Colt & Co., 3 West 29th street, New York.

INCLOSED ARC LAMP.

The non-focusing alternating current arc lamp shown in the accompanying illustration is applicable to circuits of from 7000 to 16,000 alternations per minute, and voltages from 100 to 120.

The principal features of the lamp, which is but thirty inches in length, are the ring type of clutch used, the carbon grip and substantial construction throughout. The mechanism is so designed that all joints or pivotal connections between moving members are taut at all times, so that there is no lost motion to take up, either in striking the arc or during the burning of the lamp, thus insuring noiseless operation.

The solenoids are easily removable, and a reactance coil placer is placed in the canopy easy of access for adjusting voltage. The loss in the lamp is but 20 watts when adjusted to the 6 amps. on a 100 or 110 volt line; the consumption in this case is usually from 400 to 450 watts, giving an average efficiency of 95 per cent. The carbons used are ⅛ and 1-16 in. core, each 8 ins. long. By using the stub of the upper carbon for a lower in the succeeding run, but one fresh trim per carbon is necessary. The life of one pair is 80 hours.



JANDUS INCLOSED ARC LAMP.

The above described lamp is made by the Jandus Electric Company, Cleveland, O.

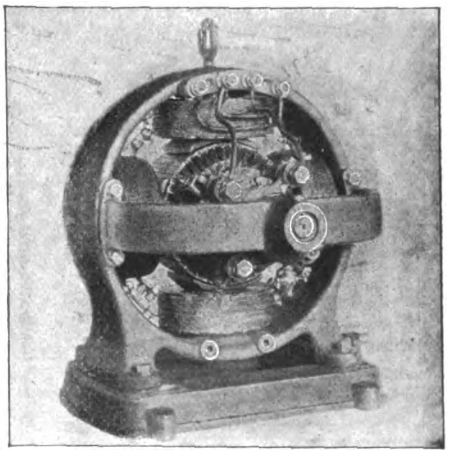
KEYSTONE MULTIPOLAR OPEN-TYPE GENERATORS AND MOTORS.

Realizing the fact that there is a brisk demand for small dynamos and motors that are really reliable, and in which efficiency is not sacrificed to cheapness, the Keystone Electric Company, of Erie, Pa., has placed upon the market such a line of machines.

The field frame is of cast steel and the market has been thoroughly searched for a grade having the best magnetic properties and at the same time capable of pouring perfect castings. Both the outer and field surfaces of the pole piece are bored to exact dimensions, thus securing a truly balanced field, with a minimum of clearance. Substantial pole pieces also serve to reduce the reluctance of the magnetic circuit. The bearings are self-oiling, supported in brackets bolted to the field frame, and so designed as to permit the motor or dynamo to be bolted to the floor, wall or ceiling.

The field coils are wound upon spools, the cylindrical portions of which are carefully drawn seamless copper tubes with flanged ends, which secure the end flange; the tubes fit closely, without driving or forcing, in the turned surface of the pole pieces, thus reducing the length of the poles and obviating any vibration. Another valuable feature of the copper mounting is that its action as a closed secondary reduces the inductive e.m.f. due to field discharge. The coils are wound with strict regard for layers and turns, each bobbin having the same number to a fraction. Each coil is wound in two parts, the terminals being both outside ends.

The ring type of armature is used, and the core is built up of a fine grade of laminated steel which is tested for permeability and hysteretic losses before being accepted from the makers. The complete core is carefully filed smooth, balanced and insulated with layers of mica and rubber cloth. The coils are wound in place tightly by hand, each coil being covered with a strip of fiber, between which and the overlapping teeth a hard wood key is driven which holds the coil rigidly in place, thus affording a superior mechanical construction. This method of winding and securing is particularly desirable with respect to repairs, which can be readily made in localities far from repair shops.



KEYSTONE MULTIPOLAR DYNAMO AND MOTOR.

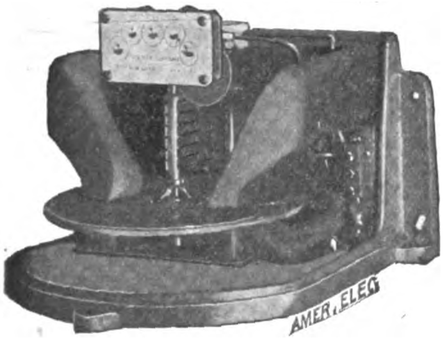
The commutator is made of solid forged bars, insulated with the purest India mica, the segments when completed being powerfully compressed in a heavy clamp. A brush wearing surface has been provided both deep and broad, the current density not being allowed to exceed 30 amps. per sq. in. of brush contact. The brush holders are of the reaction type.

Speed considered, this machine is claimed to be unexcelled in efficiency per pound of material, and is therefore exceptionally well adapted where lightness is a consideration, in portable plants of all kinds, and for wall and ceiling work.

WALKER INTEGRATING AMMETER.

The new Walker integrating ammeter, shown in the accompanying cut, is a direct reading recording ammeter adapted for continuous currents, registering ampere hours. Two powerful permanent magnets act on a thin copper disk rotating between them. On the surface of this disk are mounted three coils, each having a common connection in the disk itself, and presenting their free ends to a long three-part commutator of small diameter. On this commutator rest three broad copper brushes, which in the cut seem to be very stiff and apparently productive of much friction. Such, however, is not the case, and the contact that the brush makes with the commutator, while extremely reliable, is surprisingly light, the friction being negligible.

The greater volume of the current that the meter measures passes through a shunt to the terminals of which the brushes of the meter are connected. The copper disk renders the speed of the meter proportional to its torque, and its torque is proportional to the current in its armature wires, which is, of course, proportional to the main current. Therefore, the instrument measures ampere hours if properly calibrated. By varying the shunt the capacity of the meter can be varied, and in this way it can be supplied in large sizes at low proportionate cost.

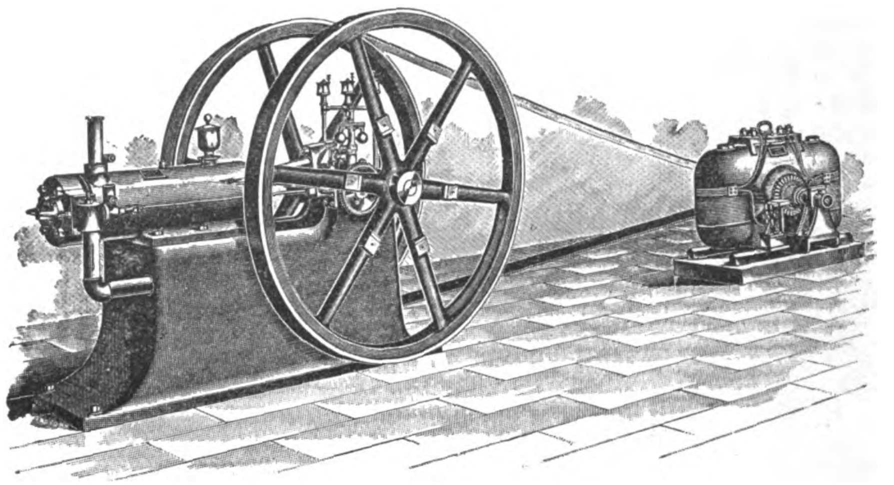


WALKER INTEGRATING AMMETER.

WHITE & MIDDLETON GAS ENGINE.

The gas engine shown herewith, direct-connected to a dynamo, is claimed by the makers to be especially suitable for electric work, and, on account of the simplicity of its construction, not to require expert attendance.

There is no mechanism attached to the crankshaft to control the movements of the engine, excepting the governor, thus adding to the simplicity of the machine. The igniter is simple in design and construction, having no springs or special mechanism to control it. The manufacturers of this engine prefer a low speed, for the reason that this adds to the life of the machine, lessens the amount of lubrication and calls for less skill on the part of the attendant. They also rate their machines according to brake horse power, each machine being tested before being sent out, and a guarantee given as to its gas consumption. This method of rating gas engines by brake horse power is the only proper one, as the indicator card includes the work of three idle strokes, which is negative and varies widely in different makes of engines.



WHITE & MIDDLETON GAS ENGINE.

The engine described is made by the White & Middleton Gas Engine Co., Baltimore, Md.

AMERICAN HIGH-GRADE ARC CARBONS.

That the highest grade of arc carbons—such as are best fitted for constant potential lamps—have in the past been supplied from abroad has by some been held to be little creditable to American carbon manufacturers. In cases where the latter have acknowledged the superiority of German carbons, such a concession has usually been accompanied by the statement that the proper grades of crude material cannot be obtained in this country. On the other hand, it is said that the leading German makers of carbons keep their process of manufacture secret, the mixture of materials being made behind locked doors by a trusted employee or even by one of the firm, and that in view of this the assumption that the component materials differ from what may be procured in this country requires evidence that has not yet been offered.

The latter view has for years been held by Mr. J. S. Partridge, of the Partridge Carbon Company, Sandusky, Ohio, during which time he has almost continually been experimenting with the object of finding a mixture of American material and a process of manufacture that would produce carbons equal to imported ones. Mr. Partridge states that he has recently succeeded in accomplishing his purpose, and at the New York Electrical Exhibition he placed a number of his carbons on trial in various arc lamps burning in the hall. The conditions were sometimes so severe that the ordinary American carbons could not be used at all, but all seem to have been successfully met by the new carbon, according to the testimony of the disinterested persons whose lamps were used, among whom are several makers of arc lamps.

Other evidence of the superiority of the new carbon, which supplements the above practical tests, is offered in a report recently made by Mr. J. S. Wood, a competent electrical engineer and member of of the firm of Wood, Shaw & Company of New York. A pair of carbons were placed in a 110-volt 4½-amp. Bergmann lamp at 11.30 a. m. of May 5, and kept burning until 12.30 a. m. of May 7, a period of 49 hours. At the beginning of the test the length of the carbons was 12 and 5 ins. respectively, and at the end 10 and 4¾ ins., showing a consumption of but 2¼ ins. in slightly over two days. This new grade of carbons will, we learn, be very soon placed on the market.

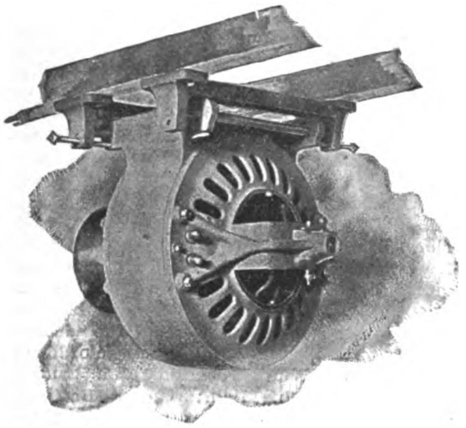
COMMERCIAL IRONCLAD MOTOR.

The accompanying engraving shows a new type of commercial ironclad motor which has just been placed on the market by the Commercial Electric Company of Indianapolis, Ind. As will be seen, it is compact and attractive in appearance, as well as thoroughly protected from mechanical injury, dust and dirt, while the large lids which are placed in the casing above and below the commutator allow of easy access to the brushes when desired.

The method of mounting is especially adapted for ceiling suspension as well as for installation directly on the floor or foundations. When suspended, as shown in the cut, the operation of the belt-tightening device is in no way interfered with. Since there are no bolts to be loosened, the machine can be mounted on its support, as with other ceiling machines.

This type is convenient for belting direct to elevator machines when used in this way, and a special reversible motor and controller is made for this purpose.

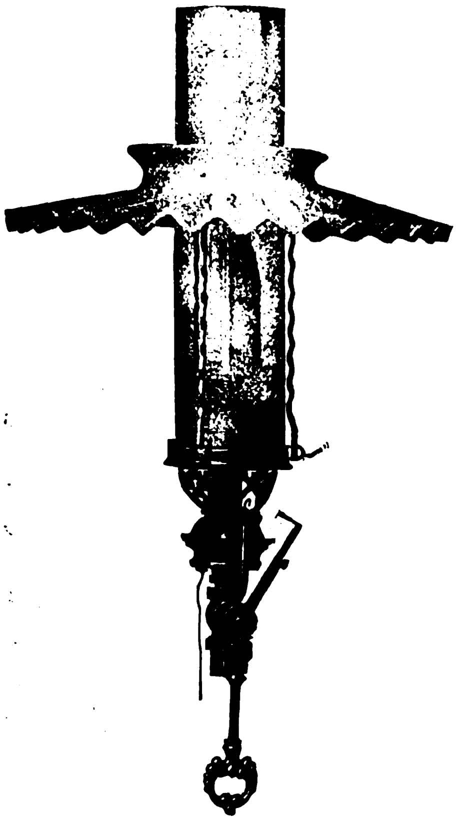
The magnet frame is of steel with circular cores and pole shoes of the same material, thus affording a low resistance air-gap and the greatest possible efficiency of the magnetic circuit. The end casings-which carry the bearings are of cast iron and provided with ample ventilating holes. The shafts are of steel, and the bearings self-oiling, with bronze linings, which are easily renewed. Carbon brush holders of simple construction and large capacity are used, and, owing to a strong magnetic field, sparking with change of lead is avoided.



COMMERCIAL IRONCLAD MOTOR.

ELECTRIC GAS LIGHTING ATTACHMENT FOR INCANDESCENT BURNERS.

For a practical method of lighting incandescent burners, an attachment has been designed which embodies the improvements found in the "Advance" electric gas lighting burner. Among them are the smooth, easy action in lighting, which will not break the mantle; its operation by key in the same manner as the ordinary gas cock, and the fact that there is no possibility of the burner becoming short circuited in extinguishing. An additional feature is an adjustment in the pilot tube, by which the size and height of the pilot flame can be regulated. This obviates the blackening of the mantle, frequently found in burners lit from a pilot tube where too large a flame issues from same.



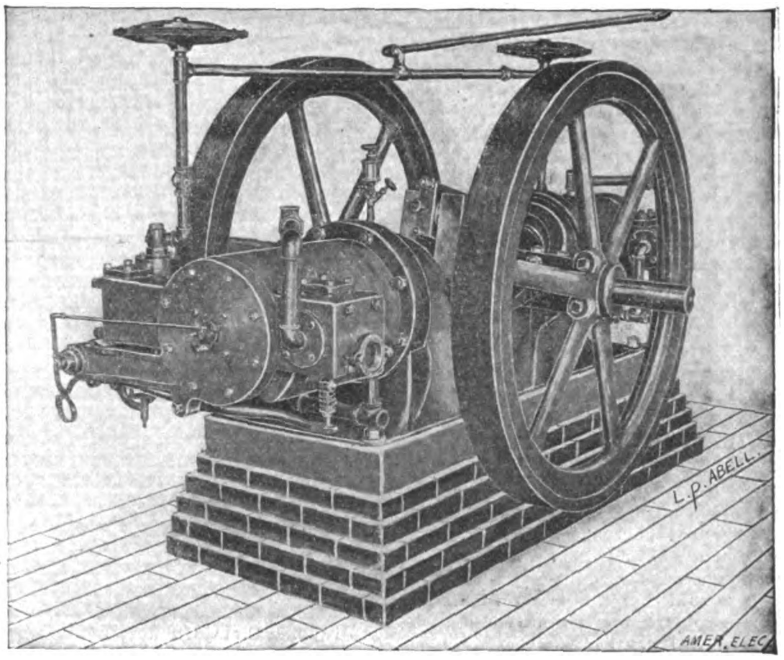
ADVANCE GAS LIGHTING ATTACHMENT.

The attachment can be used with the Welsbach (as shown in illustration), and a majority of the other incandescent burners now on the market, and require but a few moments to attach. The Electric Gas Lighting Company, 193 Devonshire street, Boston, Mass., are the manufacturers of this device.

LAMBERT GAS ENGINE.

In the type of engine herewith illustrated, the Otto cycle is utilized, and to obtain unvarying speed two cylinders are used, facing each other on same bed, and working on separate cranks. The shortening up of the connecting rod gives the piston more travel for the first ¼ revolution, on outward stroke of piston, which results in several advantages, one of which is that the impulse of explosion is not given to the wheels suddenly, thus steadying the motion.

A double-cylinder engine built with a double crank is particularly applicable for driving dynamos. The cranks balance each other, and therefore the wheels can be balanced. The pistons, always traveling in opposite directions, balance each other when their motion is reversed. This plan of building admits of speed without the attending vibration. The accompanying engraving is reproduced from a photograph of a Lambert double-cylinder 50-h.p. engine, manufactured by the Lambert Gas & Gasoline Engine Company, of Anderson, Ind.



LAMBERT GAS ENGINE.

NEW BOOKS.

THE ELEMENTS OF ELECTRIC LIGHTING. Including Electric Generation, Measurement, Storage and Distribution. Ninth edition. By Philip Atkinson, A. M., Ph. D. New York: D. Van Nostrand Company. 279 pages, 104 illustrations. Price, $1.50.

That this book has passed into a ninth edition is evidence that it meets a real need. The purpose of the book is to set forth the various facts pertaining to electric lighting in plain language, devoid of technicalities and mathematics. It is therefore well adapted to the needs of the general reader, the business man and others who desire, without entering into the technics of the subject, to obtain an intelligent understanding of it.

THE POWER CATECHISM. Correct Answers to Direct Questions Covering the Main Principles of Steam Engineering and the Transmission of Power. Compiled from the regular issues of *Power*. New York: Power Publishing Company. 226 pages, 131 illustrations.

This is easily the best catechism of practical steam engineering yet published, combining three essentials in a book of instruction—logical arrangement, pertinent selection of questions, and accuracy united with conciseness in answer. The steam engineer who masters this volume will be amply able to cope with any examination that may be set before him, and able also to undertake with confidence the care and management of a steam plant containing new features that would stagger the man who depends only upon knowledge required from direct experience.

THE ESSENTIALS OF GEARING. A Textbook for Technical Students and for Self-instruction, Containing Numerous Problems and Practical Formulas. By Gardner C. Anthony, A. M. Boston: D. C. Heath & Company. 84 pages, 37 illustrations and 15 plates. Price, $1.50.

Especially addressed to students having no previous knowledge of the principles involved, by such this will be found to be an excellent treatise on the design of gears. All of the various points involved are illustrated, not by diagrams meaningless to the practical draftsman, but by actual drawings of gears.

BUSINESS NEWS.

THE STILLWELL-BIERCE & SMITH-VAILE CO. have moved their Eastern office to 141 Broadway, New York.

MR. HUGO DIEMER, formerly of Diemer & Hebble, Cincinnati, has accepted a position with the Westinghouse Electrical and Manufacturing Company, at Atlanta, Ga.

ALBERT B. HERRICK, consulting electrical engineer, has changed his offices from 150 Nassau Street to 120 Liberty Street, where he will be nearer his clients and have more room for his rapidly increasing business.

THE ELECTRICAL EXCHANGE, Chicago, is meeting with much success in introducing "Midget" Upton arc lamps, both direct and alternating current. Among recent orders from a distance was one from St. Michaels, Alaska.

NAVAL FIGHTERS.—The Central Electric Company, 264 Fifth Avenue, Chicago, has issued a card folder containing a list of all American and Spanish men-of-war, with their displacement, horse power, armament, speed and year built.

THE AMERICAN STOKER COMPANY has removed its offices to Washington Life Building, Broadway and Liberty Street, New York. A new catalogue of the American stoker has just been issued, on which no expense has been spared to make it a work of art.

X RAYS AND ELECTRO-THERAPEUTICS.—The L. E. Knott Apparatus Company, 14 Ashburton Place, Boston, have issued a fifth edition of their pamphlet with the above title, which illustrates and points out the advantages of a number of types of static generators and other apparatus.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, has just issued a handsome catalogue of its special coiled filament lamp, which has taken high rank in the market for economy and sustained candle power. The manufacturers offer special inducements to consumers on the basis of yearly supply contracts.

A. O. SCHOONMAKER, 158 William Street, New York, reports a good demand for his mica. He is prepared to cut any special pattern or size, and build to any thickness. His mica washers and bushings are particularly popular for repairing arc lamps. Owing to the large stock carried, shipments can be promptly made.

MR. J. E. KEELYN, president of the Western Telephone Construction Company, Chicago, has secured control of the Graham Electric Company's telephone and switchboard business, including all patents relating thereto. It is said that this is the fifth company whose control has recently been secured by Mr. Keelyn.

WESTERN ELECTRIC BULLETINS.—Bulletin 1F of the Western Electric Co. is devoted to alternating current fan motors, giving a complete description of the type, with illustrations. Bulletin 2F is on ceiling fans for direct current, of which four different styles are illustrated. The descriptions are particularly clear.

PARAGON FANS AND MOTORS.—The descriptive catalogue and price list No. 3 of J. P. Williams, 39 Cortlandt Street, New York, is devoted to Paragon fan and power motors. The Paragon motor, all the parts of which are shown in detail, is one entirely inclosed, thus being particularly adaptable for many uses where the attendance is unskilled.

STEPHEN D. LARGE & CO., 321 Chestnut St., Philadelphia, Pa., successosrs to Large & Twining, report a very gratifying increase in orders for their knife switches and switchboards. They have completed a handsome board for the Beachwood Inn, at Jenkintown, and are now engaged in a rush order for a marble center of distribution for the new steel pier at Atlantic City.

CHARLES WIRT, 1028 Filbert Street, has taken enlarged quarters at the same number, for the extension of his rheostat business. Mr. Wirt has recently issued a new price list and rating of rheostats intended to call attention to the superiority of the Wirt rheostat, particularly in regard to performance under conditions of abuse, such as overloading and sudden heating.

GREENE-WHEELOCK ENGINE. — The American Wheelock Engine Company, Worcester, Mass., have issued a well-illustrated pamphlet, in which the new and improved type of Greene-Wheelock engine is shown and described. The main features of this engine are the Wheelock underneath valve, the Hill cam valve gear and the Greene positive cut-off.

THE CARE OF BOILERS.—All interested in steam generation will find much of value to them in Lord's "Essays upon Boiler Incrustation and Corrosion, Boiler Explosions and the History of Natural Water Contamination." A copy of this interesting pamphlet will be sent upon application to George W. Lord, Philadelphia, to any subscriber of The American Electrician.

LIGHTNING PROTECTION — Switch Boxes.—In circular 102 the D. & W. Fuse Company, Providence, R. I., deal with the protection of telephone and similar circuits against lightning and sneak currents. The principles concerned are clearly explained and their application shown by reference to illustrations. In circular 103 a new type of service switch box is illustrated and described.

THE STANLEY ELECTRIC MANUFACTURING COMPANY has moved its New York offices from 39 Cortlandt Street to the new Empire Building, corner Broadway and Rector Street, where it now occupies quarters more commodious and better adapted to accommodate the conditions of its growing business. The new offices are on the tenth floor, on the Broadway corner, and are both light and pleasantly situated.

THE CENTRAL ELECTRIC CO., Chicago, has removed from 173 Adams St. to 264-270 Fifth Ave., where it now occupies largely increased quarters. The size of the quarters may be judged from the fact that the stock room contains no less than 1,500 bins. A system has been adopted whereby the stock keepers can always be fully advised of the quantity of material on hand, and can assemble orders in the shortest possible time.

THE LYNN INCANDESCENT LAMP CO., of Lynn, Mass., state that nine out of ten of their shipments are to old customers, and that five out of eight are to lighting stations, which they believe demonstrates that station managers are appreciating their efforts to furnish them with a good lamp at reduced cost, and that they are making it possible and profitable for the station manager to use a lamp of a higher efficiency and to replace them oftener.

EUGENE MUNSELL & CO. AND THE MICA INSULATOR CO., of New York and Chicago, last week completed arrangements with the George Worthington Co., of Cleveland, whereby they become distibuters of both "Mica" and "Micanite." Their territory includes the city of Cleveland and some eight or ten of the adjoining counties. A large stock of India and amber "Mica," in the sheet and segments for railway motors, as well as "Micanite" plate, segments, rings, cloth, paper, etc., will be carried to supply the electrical trade in that section.

THE SPRAGUE MULTIPLE-UNIT SYSTEM.—The managers of the Alley L road, of Chicago, which is now installing the Sprague Multiple-Unit system, report that as soon as the steam trains are off the line they will be able to reduce their schedule from thirty-eight to thirty minutes, and that they will save in transportation wages alone more than the total depreciation, and will make the old steam service mileage with 15 per cent. fewer cars. They also report that the strains on their structure are noticeably reduced, and that the increase in their traffic has already added quite a percentage to their receipts.

CORRESPONDENCE INSTRUCTION.—A glance over the course in electrical engineering offered by the American School of Correspondence, Boston, Mass., shows it to be thorough and comprehensive. Among the advisors and instructors are Mr. Charles Thom, who for many years has been at the head of the quadruplex department of the Western Union Telegraph Company, and is a man well known among electricians throughout the country. The school confines its attention exclusively to electrical, mechanical and steam engineering, the instruction in which is made as simple, practical and scientific as possible.

UPTON "MIDGET" LAMPS.—The Standard Thermometer & Electric Co., Peabody, Mass., at present supply Upton "Midget" inclosed arc lamps for both high and low frequencies, properly marked binding posts indicating the connection for one or the other. The lamps are also adjustable for from 4 to 6½ amps., as may be desired. Among recent sales have been large orders to central stations at Taunton and Hudson, Mass.; Tecumseh, Mich.; Green Bay and Oshkosh, Wis.; and among recent orders from Edison stations have been 100 for Los Angeles, Cal. An order has also just been received for 50 lamps from a Mexican Central station.

STREET RAILWAY MOTORS.—Thirty-six double equipments of 35-h.p. motors have been ordered from the Westinghouse Electric and Manufacturing Co., by the Cleveland Electric Street Railway Co. Apropos of Westinghouse motors, in a recent letter the superintendent of a street railway writes that a 30-h.p. Westinghouse equipment has been in service on his road for 592 days, making 200 miles per day, without a single repair to any part of the machine, except renewal of bushings and bearings. The motors were on a 30-ft. closed car, running over the hardest part of the road, with less than five minutes lay-over at either terminus from 6 a. m. to midnight.

ROBERTSON COMPANIES.—The business heretofore conducted under the firm name of James L. Robertson & Sons has been dissolved and two new firms organized. Of these, James L. Robertson & Sons will give their attention to the sale of Eureka, Fairmount square flax and all other packings, Hine eliminators, steam separators and oil extractors, engineer and mill supplies. The Robertson Manufacturing Company will make a specialty of manufacturing indicators and their attachments, together with feed water heaters, grate bars, exhaust heads, damper regulators and other mechanical steam specialties. Mr. James L. Robertson will remain at the head of both concerns, the former of which will include in addition Mr. Frank Robertson, and the latter, Messrs. Jas. L. Robertson, Jr., Wm. Robertson, A. C. Lippincott and Thos. G. Keogh.

AN ELECTRICAL FACTORY FLOODED.—The factory of the Hobart Manufacturing Company, Troy, O., was recently partly submerged, owing to a very peculiar flood. The factory of this concern is located to the south of a large storage reservoir, which supplies power to turbines for pumping the city water supply. The heavy Spring rains recently caused the reservoir to break through the waste way and cut an immense gap in the reservoir banks. A great flood of water poured over the lower part of the city, in which the factory of the Hobart Company is located, and in a few hours the water was several feet deep in the Hobart factory and warehouses. The loss to this company was considerable, as a great part of their stock was flooded, besides 14 dynamos and motors that were completed and ready for shipment. Considerable damage was also done to the office, and, altogether, it was some time before the force could carry on its work without considerable inconvenience. Manufacturing was suspended for four days, while the entire force was engaged cleaning out the mud and repairing the damage wrought by the flood. The Hobart Company are at present, however, working overtime to catch up on their orders.

EXHIBITION NOTES.

THE ELECTRICAL EXHIBITION held at Madison Square Garden, New York, during the month of May, showed much progress over the one held at the Grand Central Palace two years previously, particularly in features of general interest and in its instructional departments, there being more than a score of the latter. That the public appreciated the efforts made to entertain them was shown by an attendance under remarkably adverse weather conditions that probably no other show could have obtained.

Among the exhibits of general interest was that of the Edison ore separator system, which was here first shown in its entirety, and a model plant enabled all of its details to be understood. Another, and perhaps the most interesting exhibit to the general public, was that of a full-size section of the Madison Avenue underground trolley road, over which a fully-equipped car was kept in almost constant to-and-fro motion. All of the details of sub-trolley construction were shown, incandescent lamps being so placed as to make the interior details plain, and the mechanism for taking current from the conduit conductors could be seen in actual work, and was also shown in a separate exhibit. The car used was of the Stephenson make, and was equipped with a complete Walker outfit.

An extremely interesting exhibit was one made by the Safety Insulated Wire and Cable Co., consisting of a large tank, with a glass front, showing applications of submarine cables. The United States lighthouse system of electrically lighted buoys was shown in miniature, and also models of submarine torpedoes. With fish swimming in the tank and tiny electric lamps glowing on the spar buoys, the illusion was perfect.

The exhibit of Mr. W. J. Clarke of the Marconi system of wireless telegraphy always attracted large crowds. This was a working exhibit—a transmitter on one side of the hall operating a Morse receiving apparatus on the opposite side. The signal, "N. Y.," in Morse characters, remittantly obtained by means of a slowly revolving make-and-break wheel, was reproduced at the receiver, and sounded on a gong there.

The Moore system of vacuum tube illumination applied to light the interior of a chapel was perhaps the most novel feature of the exhibition. The chapel was a large and well executed model of a vaulted church, and sufficiently large to seat 50 or more people; the illumination was furnished by vacuum tubes, which followed the contours of the arches or lay in cornices at the junction of the arches with the main walls. An organ at one end of the chapel discoursed sacred music. The light produced an effect so closely approaching that of daylight as to be commented upon by almost all visitors.

OPERATIVE SECTION.

To the electrical engineer, if he corresponds to the definition of Lord Kelvin, and is consequently nine-tenths mechanical engineer, the most interesting part of the exhibition was the operative section in the basement. Here two Babcock & Wilcox boilers, of 265 h.p. each, were located, being part of the boiler plant of 16,000 h.p. now being erected for the Metropolitan Railway Company of New York. The boiler under steam was fitted with the Beeckman system of automatic control mechanical draft, the air being delivered into closed ash pits, and the speed of the fans regulated by the boiler pressure.

Of engines and generators there were the following, all direct connected: A vertical New York Safety 125-h.p. engine, driving a 125-volt Fort Wayne generator; an Armington & Sims engine, driving a 50-k.w. 125-volt Walker generator; 35-h.p. American Ball engine, driving a 25-k.w. generator; a Fischer engine, driving a 75-k.w. Onondago dynamo; and a Woodbury engine, driving a 25-k.w. Eddy generator. In comparison with practice of a few years ago, two facts in connection with these exhibits were conspicuous—all of the generating units were direct connected, and all of the engines were fitted with inertia governors. Most striking of all, however, was the fact that there was no alternating current generator in operation, and it may be added that there were no alternating current circuits in the building, a most singular omission in an electrical exhibition of the present day.

Of heat economizers there was a small but notable exhibit of standard apparatus, mechanical in design and appearance, and far from being mere pipefitters' constructions. A 150-h.p. Green fuel economizer was shown, with scrapers in operation and all principal parts exposed to inspection; a 400-h.p. American economizer, complete in all of its details, and with scrapers in operation; a very complete line of cork heat insulating, exhibited by the Nonpareil Cork Manufacturing Company of Bridgeport, Conn.; Berryman feed-water heaters and purifiers, including the latest type, which was shown alongside an older type of the same capacity but several times larger; 6-in. horizontal and vertical Cochrane steam separators, and a 350-h.p. Cochrane feed-water heater and purifier.

The gas engine department was one of the important features of the exhibition, and attracted much attention. The new Diesel motor was represented by a machine of 20 h.p. direct-connected to a C. & C. generator, the speed being 170 r.p.m. Though not intended for electrical service, and only hurriedly prepared for this purpose, it carried its load of lights with less than 1½ per cent. variation of speed, according to the statement of a representative of the company. Of the single cylinder type, the engine worked on the Otto cycle without secondary expansion, but the principle of high air compression and fuel injection on part of return stroke is used, the high compression leading to a temperature which ignites the fuel—gas or gasoline—upon its admission.

A 32-h.p. and a 4-h.p. Hornsby-Akroyd oil engine were shown, the latter operating a generator, the combination being similar to that used by the United States Government in connection with coast defense protective work. This engine uses heavy mineral oils or kerosene as fuel, and employs no igniter, the heat of the walls of a chamber forming an extension of the cylinder head, performing the function of both evaporator and exploder. The narrow neck connecting this chamber is capable of sectional adjustment, by means of which the time of ignition may be perfectly controlled.

A 70-h.p. Nash gas engine, vertical type, was shown direct connected to a Walker generator. The mechanism was of excellent workmanship, in this respect equaling the highly finished electric light engine. Electric ignition is employed on this type of gas engine, and the speed of the driven machine is kept constant by means of a coupling, which allows of a slip between the driving and drawn shaft, the amount of this slip being controlled by a sensitive centrifugal governor.

DYNAMOS, MOTORS AND ACCESSORIES.

One of the first exhibits noticed on entering the main hall was the display of H. B. Coho & Co., New York, which included a varied and comprehensive arrangement of generating and power machinery. This enterprising concern acts as selling agents for the Eddy Electric Manufacturing Company, the Warren Electric Manufacturing Company, the American Rheostat Company, the Crown Woven Wire Brush Company, Van Horne, Burger & Co., the Translucent Fabric Company, and the Otis Electric Company. The product of all these concerns was included in the Coho exhibit. The manufactures of the firm itself included some excellent switchboard and similar devices. Particularly notable was a switchboard constructed of a sheet of ¾-in. French plate glass, three by five feet square, having mounted thereon a complete switchboard equipment for two dynamos. A large number of Eddy motors, with novel starting boxes, manufactured by the American Rheostat Company, were shown in operation, and also a Warren alternator driven by an Eddy motor and furnishing a multi-volt alternating current.

Located on the center aisle was the space of the C. & C. Electric Company, New York, where a large and excellent display of the very latest types of motors and dynamos was made. The exhibit included several large direct-connected multipolar generators up to 60-k.w. capacity. In the way of motors, several of the new iron-clad inclosed type machines recently brought out by this company were shown. An interesting exhibit was an 18-h.p. double drum hoist. A 60-in. fan operated by a direct connected series motor, with commutated field regulation, also attracted a great deal of attention whenever it was set in operation. The new C. & C. starting boxes were displayed in great variety.

Owing to a great rush of business at the factory, the Bullock Electric Manufacturing Company, of Cincinnati, Ohio, was unable to show any large amount of apparatus; in fact, no apparatus was in operation. Several large direct-connected machines were shown, and the technical visitor was particularly interested in the placards attached to them. These placards state that the machines are guaranteed for twenty-four hours' operation at full load, and will take overloads of 50 per cent without sparking.

A 150-k.w. multipolar direct-connected type generator formed the center piece of the exhibit of the Crocker-Wheeler Electric Company, New York. Around this large unit, which was probably the jumbo of the exhibition, were grouped a great number of smaller sized motors and dynamos manufactured by this company. The neat arrangement was particularly notable, as well as the fact that the motors shown ranged from the smallest production of the company up to the larger sizes in gradual steps. The motors were all arranged according to size, and kept in frequent operation. The new motor starting boxes and rheostats, including mica and iron rheostats for large motors, were particularly noteworthy, and the new Crocker-Wheeler mill motors were much discussed. This space was one of the largest and best arranged at the exhibition.

The Fort Wayne Electric Corporation, Fort Wayne, Ind., had a very comprehensive exhibit, which included the only operative and distributing alternating current generating plant in the exhibition. A 37½-k.w., 60-cycle single-phase alternator was coupled direct to, and driven by, a four-pole motor. The current from the generator was supplied to various exhibits, and also to a lamp bank and switchboard, forming part of the exhibition. A striking feature of this exhibit was an 80-light 2,000 candle-power arc machine, of the latest Fort Wayne design, direct coupled to and driven by a 110-volt motor. Arc and incandescent lamps were also shown in profusion, and the integrating Duncan meters for alternating current attracted much attention.

Although the Walker Company, Cleveland, Ohio, was the sole exhibitor of electric railway apparatus, it may well be said that their display was certainly most comprehensive and thorough. At the main space the latest productions in railway motors were shown, and a fully equipped Peckham street car truck, with motors operated by means of the new solenoid controllers, was a prominent feature. The new recording ammeter was probably one of the most interesting appliances shown at this exhibit. This device is practically a small motor, with three flatly arranged disc-like armature coils, and a permanent steel magnet. In addition to the exhibit at this space, the Walker Company showed at the other end of the main arena a complete section of their new open slot conduit electric street railway. This section of conduit road is full size, and equipped with all the necessary fittings, and a standard

Metropolitan Traction Company car was kept in almost constant operation thereon. The complete arrangement is such that every part of the entire system could be inspected by the visitor, and the exhibit undoubtedly formed one of the most attractive and instructive features of the show. The Walker Company also exhibited a new alternator which attracted a great deal of attention. In this machine the rotating multipolar field has but a single coil, and the fixed armature forms an exterior ring, so that it can be connected for varying voltages.

In the upper gallery, the Card Electric Company of Mansfield, Ohio, showed three large motors and dynamos of their very latest inclosed type. The largest of these is a 25-h.p. slow-speed 110-volt machine. These machines are built for heavy service, and are thoroughly protected in every way. A notable feature is the removable commutator cover, making this part of the machine thoroughly accessible, and yet well protected. The Card starting boxes, used in conjunction with these motors, are of a most excellent design, operating on under or overload. A single double-wound magnet, acting on two trip armatures, one for overload, the other for underload, is used for both of these functions.

Almost 150 fan motors were shown in operation at the exhibit of the Paragon Fan Company, represented by Mr. J. P. Williams, New York. The motors were arranged on a wooden pyramid, and when in united operation caused a disturbance in the atmosphere which was felt far and near. A placard stating "The hand that rocks the cradle rules the world," which was attached to a child's cradle operated by a small Paragon motor, attracted the feminine visitor.

Probably one of the most varied and general exhibitions of electric motive power was made by the Sprague Electric Company, New York. In fact, the Sprague exhibit might well have served as a complete exhibit of electric motors and their application. Elevator apparatus was shown in great profusion, from the small automatic house machine to the very largest production, as shown by one of the machines for the Central London Underground Railway. This machine is of the duplex tandem worm gear drum winding type, and has a capacity of 80,000 lbs., at 100 ft. per minute. About fifty of these machines will be installed. The motor exhibit also included a Sprague screw elevator machine, and a large Miele printing press operated by a direct-connected Lundell motor, sidewalk, hoists, &c. An interesting feature of the exhibit was a large pipe organ, with electric blowing apparatus. In addition to the motor display, various small generating sets were shown, including Lundell dynamos and the standard interior conduit system, with its various accessories.

ARC LAMPS.

The exhibition of arc lamps formed one of the really striking and brilliant features of the exhibition, and the supremacy of the inclosed arc lamp was particularly notable.

The products of the International Arc Lamp Company, New York, represented by Mr. George R. MacIntire, were almost everywhere. Starting with the immense "arkolier" in the center of the arena, containing twenty-four MacIntire inclosed arc lamps in three tiers, down to the small baby lamps at some of the booths, MacIntire lamps shone from all sides. They were placed in many of the booths, and attracted a great deal of attention, not only owing to the compactness of design, but also to the fact that the control and operation of the lamp is due to a single series solenoid operating a ball clutch, without any other mechanism whatever. Mr. MacIntire, like his lamps, was omnipresent, and always ready to explain the fine points of his wares.

A.-B. arc lamps were exhibited in the space occupied by Elmer P. Morris in the gallery, by the Adams-Bagnall Electric Company, Cleveland, Ohio. The exhibit included a large variety of lamps intended for 110, 220 and 500 volt constant-current service. A 220-volt inclosed lamp, burning singly across the line, was an interesting feature of the exhibit. A marine arc lamp which burns 125 hours at one trimming was also shown. This lamp is used quite extensively on lake steamers.

The Excelsior Electric Company, Brooklyn, N. Y.; the Fort Wayne Electric Corporation, Fort Wayne, Ind., and the Walker Company, Cleveland, Ohio, also showed their latest production in inclosed and other arc lamps.

A departure from the usual lines in the construction of arc lamps was shown at the exhibit of J. Jones & Son, New York, in which the usual electro-magnetic mechanism has been entirely displaced. This lamp, as the "Toledo,' is controlled by a hot wire. Its excellent operation and extreme simplicity of construction seemed to convince all who inspected it that hot wire lamps have a future.

The exhibit of the Ziegler Electric Company, Boston, Mass., which was made at the space occupied by Stanley & Patterson in the gallery, included some novel projecting and focusing lamps. The Empire stage lamp —which is particularly attractive and novel— has the two carbons at right angles. Fourteen of these lamps were used in the illumination of the Garden tower. The new inclosed arc lamp for various circuits was also shown.

STORAGE BATTERIES.

The exhibit of storage batteries was confined to a large and very comprehensive display made by the Electric Storage Battery Company, Philadelphia. A great deal of credit is due to this concern for the thorough object lesson which had been arranged. The various types of storage batteries manufactured by the company, from the largest down to the smallest, were shown, many of which are in constant operation.

One of the very large cells built for the Chicago Edison Company was of particular interest. The cell was mounted in a case with glass windows, which clearly showed the eighty-three plates. It has a capacity of 6,000 amperes at a one-hour discharge rate. A fully-equipped storage battery launch, of the latest design, manufactured by the Electric Launch Company, was also shown. By no means the least interesting feature of the company's exhibit was the very large Willyoung X-ray coil, giving a 12-in. spark, which was operated by portable batteries. The welding experiment, which was shown at intervals, illustrated the immense capacity of the company's 11-F. cell. This single cell was kept constantly charged, and heavy leads were taken from it to an adjacent welding machine, in which the current from the single cell melted heavy eight-penny steel wire nails, and afterward re-welded them together. The current taken at times amounted to from 1,000 to 1,500 amperes.

CARBONS AND CARBON SUPPLIES.

The various exhibits of carbon and carbon supplies were all located on the gallery floor. The variety of carbon supplies shown was certainly most complete.

The National Carbon Company, Cleveland, O., showed a great variety of carbon productions, among which was a large assortment of electric light and other carbon rods, including some exceptionally large carbon bars or rods used for smelting purposes. The exhibit also included various carbon cells manufactured by the company, among which were the "Klondike" and the "National Fuller." A special gas engine cell has an e.m.f. of one volt with an extremely low internal resistance. Large sizes of this cell give a current of about 20 amps. on short circuit. Various carbon supplies for telephone and similar purposes were also displayed.

The Partridge Carbon Company, Sandusky, O., had a large exhibit of self-lubricating carbon brushes, arc light and other carbons. Their interests are well taken care of by Wood, Shaw & Co. A new electric light carbon for inclosed arc lamps recently developed by this company will surely effect an important advance in inclosed arc lamps.

The Crouse-Tremaine Company, Fostoria, O., showed almost everything in carbon products. Very massive carbons for smelting and electric furnace work were of particular interest.

The LeValley Vitae Carbon Brush Company, New York, N. Y., exhibited LeValley Vitae carbon brushes at their space in the gallery.

The interests of the Washington Carbon Company, Pittsburg, Pa., were being well looked after by the Ward Electric Construction & Supply Company, whose space was located on the gallery.

INCANDESCENT LAMPS.

Almost adjacent to the Madison avenue entrance was the exhibit of Thomas A. Edison, Jr. The main feature of his exhibit was an immense disc of light, about seven to eight feet in diamater, formed by the various types of Edison, Jr., lamps. These were arranged in concentric circles, and when illuminated threw out a perfect blaze of illumination. Lamps of all sizes and shapes and for all purposes were shown, and the exhibit undoubtedly was one of the most striking illustrations of the variety of modifications to which the incandescent lamp is susceptible.

On the gallery floor was the exhibit of the Fostoria Incandescent Lamp Company, Fostoria, O. The space occupied by this concern was most artistically decorated, the prominent feature being Fostoria miniature lamps almost completely covering several columns arranged about the edge of the space. The exhibit includes Fostoria standard lamps of all candle powers; duplex double-candle power, a special four-filament, 200 candle power, and railway, fancy, etched and other lamps. When in full swing the exhibit was one of the really brilliantly illuminated of the smaller exhibits.

The lamp exhibit made by the K. & W. Company, Pittsfield, Mass., was located on the main floor. A great variety of lamps manufactured by this company was shown, and a very artistic sign, made up of miniature Hardy lamps, drew the attention of the visitor to this exhibit. K. & W. arc lamps, cut-outs, commutator lubricating compound and brushes were also shown.

A novel incandescent lamp was shown by the Fort Wayne Electric Corporation, of Fort Wayne, Ind. The tip at the large end of the globe is eliminated, giving the globe a smooth finish, and the exhaustion of the bulb is accomplished from the terminal end instead of the usual tip end, as in other lamps.

ELECTRIC PUMPS.

Entering the main arena from the Madison avenue entrance, the visitor saw before him an immense exhibit of pumping machinery which could not fail to attract his attention. The exhibit was made by Henry R. Worthington, N. Y., and could well have been called a World's Fair display. It included almost every conceivable form of pump operated by electric power, from a large duplex machine used for elevator or town supply work, down to the smallest of electric house pumps. The large electric pump is peculiar in the fact that a worm gear connection is used between motor and pump mechanism. The space occupied by the Worthington exhibit was the largest of any single exhibitor, and included over one thousand square feet.

INSULATED WIRE.

One of the most artistic exhibits was that of J. A. Roebling's Sons' Company, Trenton, N. J. The large space occupied by this concern was very elegantly arranged and divided into two rooms, one of which was filled with wire exhibits, the other being used as a reception room. The latest wire products, including Columbia rail bonds, were shown.

The exhibit of the Safety Insulated Wire & Cable Company, New York, was located in the gallery. An interesting feature which hibit. Another interesting feature which aroused a great deal of interest was a short section of submarine cable, such as would be used for telephonic connection between New York and London, with the instruments of the present day. The copper core of this cable has a cross section of 32,000,000 circular mils, and the whole diameter of the cable, including the insulation of 2 ins. and armor of 1½-in. steel rods, is about 20 ins. No information was given as to when this cable is to be installed, and it would be interesting to know its cost per mile.

The Montauk Multiphase Cable Company, N. Y., had a well-arranged exhibit on the arena floor, and showed various forms of its automatic fire-alarm cable. This cable combines ordinary distributing wires, which may be used for telephone or other purposes, with a thermostatic wire, so that automatic fire protection is afforded wherever the cable is placed throughout the building. Frequent tests at the booth aroused many favorable comments. Samples of insulating wires and cables of Habirshaw make were not displayed, but able representatives of the company were very much in evidence on the main floor.

INSTRUMENTS, FITTINGS, SUPPLIES, ETC.

Zimdars & Hunt, the well known manufacturing and contracting concern of New York, had an exhibit on the main arena floor which for artistic design was probably unexcelled. Inside of a railing made up of copper busbars, with a large switch blade serving as a gate, was a most complete array of well-designed and excellently finished switches, panel boards, feeder boards and the latest developments in the way of other switchboard appliances.

Quite close to the main entrance was the exhibit of J. Jones & Son, New York. This well-known firm manufactures and deals in all sorts of electrical supplies. Panel boards, switches and similar appliances manufactured by the concern were artistically arranged upon display boards, and a model switchboard was particularly worthy of notice, owing to the excellence of arrangement and design. A display was made of a variety of electric heating appliances. A popular attraction was supplied by a very large Toepler-Holtz machine, which was frequently in operation.

Stanley & Patterson, New York, exhibited on the gallery floor almost everything, from an electric bell to a delicate galvananometer, with a general run of supplies between. This well-known supply house also represented the Ziegler Electric Company of Boston, and the combined exhibits of the two concerns brought together a most interesting lot of electrical apparatus. Stanley & Patterson exhibited general house supplies for almost every conceivable purpose, while the Ziegler Company showed some decided novelties in arc lamps, experimental electrical apparatus, instruments, etc.

Switchboard appliances, panel boards, switches, circuit breakers, etc., were also displayed by H. B. Coho & Company and F. A. LaRoche & Company, New York. Both of these concerns showed a number of very excellent and novel panel boards. Motor starting rheostats were also shown in great profusion at the H. B. Coho space. The American Rheostat Company's latest productions were found here in great variety, and in many instances being in actual service. The new over and under load motor starting rheostat and the elevator starting rheostat were worthy of particular notice.

A large display of junction and panel boxes and fittings for interior conduit systems was made by the Bossert Electric Construction Company of Utica, N. Y. The space occupied by this concern was large, and the appliances were very tastefully arranged on artistic exhibition boards. The new steel box panel boards have many features of peculiar merit, which elicited much favorable criticism.

H. B. Kirkland, New York, had a composite exhibit on the main floor, including switches and cut-outs, manufactured by the Hope Electric Appliance Company of Providence; Cutter switches and circuit breakers, manufactured by the Cutter Electric Manufacturing Company, Philadelphia, and a good sized pyramid made up of Circular Loom flexible tubing.

E. P. Morris, whose space was located at the extreme Fourth Avenue end of the gallery, had probably a larger number of interests to look after than any other exhibitor. At Mr. Morris's space were the exhibits of the Card Electric Motor Company, Mansfield, Ohio; Adams Bagnall Electric Company, Cleveland, Ohio; Highland Electro-Chemical Manufacturing Company, Connellsville, Pa.; Keystone Electric Instrument Company, Philadelphia, Pa.; Warren Electric & Specialty Company, Warren, Ohio; Garton-Daniels Electric Company, Keokuk, Ia.; Kosmic Oil Filter Company, Easton, Pa.; D. J. Sinclair, Caledonia, N. Y.; Simonds Manufacturing Company, Pittsburg, Pa.; Forest City Electric Works, Cleveland, Ohio, and W. B. Cross, Brockton, Mass. Mr. Morris seemed to find no difficulty in handling this great variety of electrical material to suit everybody.

A decided departure in interior conduits was shown at the exhibit of the Silex Insulation Company of New York. It consists of an exterior iron pipe tube concentrically arranged around an interior brass tube with an interlining of silex powder held in position by mica plugs. The exhibit was on the main arena floor, and tube samples were very ornamentally arranged.

The Crown Woven Wire Brush Company had in the space of H. B. Coho & Co. a complete exhibit of its dynamo and motor brushes, many of which were also used on machines throughout the hall.

The H. B. Camp Company, Aultman, Ohio, displayed a variety of their vitrified clay conduit pipes, and also samples of their steel armored insulating conduit.

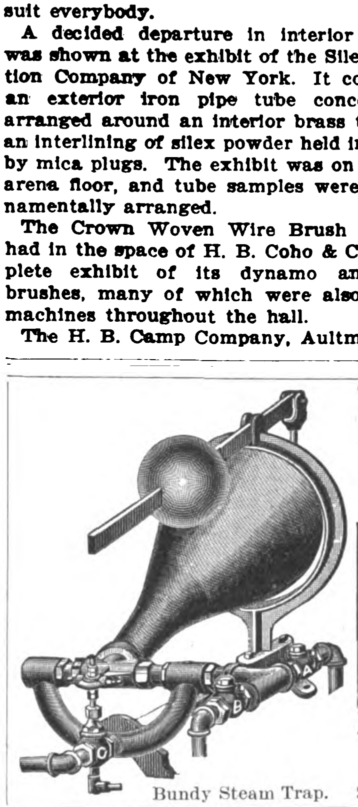
An excellent display of electrical measuring and indicating instruments was shown at the space of the Weston Electrical Instrument Company, Newark, N. J. Almost every conceivable type of measuring and indicating instrument was shown. On a panel at the back of the exhibit several very large ammeters were mounted, and attracted a great deal of attention.

The Whitney Instrument Company was represented by Machado & Roller, New York. Whitney instruments were shown in great variety in two large cases, and the excellent finish and design were much admired. This exhibit was in the space of the C. & C. Electric Company. Samples of the new A. E. G. incandescent lamps, for which Machado & Roller are American agents, were also shown here.

CAR TRUCKS, WHEELS AND TOOLS.

The puncture proof qualities of porcelain goods manufactured by the firm of R. Thomas & Sons' Company, East Liverpool, Ohio, was most comprehensively displayed by a series of tests with a potential of 60,000 volts, alternating current. For this purpose a Westinghouse testing transformer was used. The results obtained show that the Boch insulator manufactured by the concern has an enormous potential resisting ability. A great variety of porcelain insulators and other electrical fittings were shown, and the attendance at the booth was always large when tests with the 60,000-volt transformer were in progress.

The possibilities of porcelain as applied to



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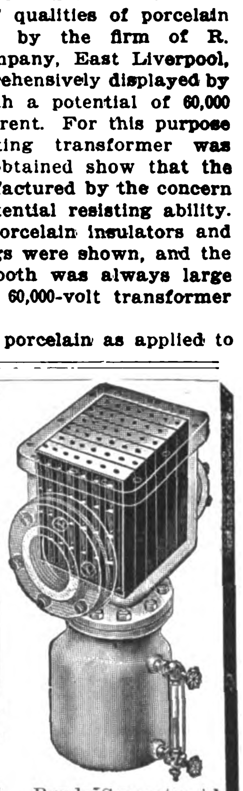

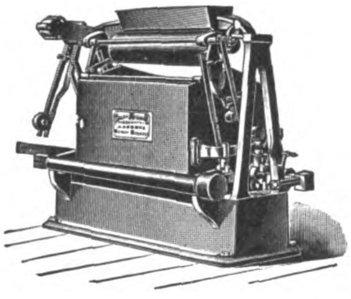

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electrical fittings and cut-outs was very fully shown by the excellent exhibit of the Peru Electric Manufacturing Company, Peru, Ind. This company showed a line of cut-out blocks with fuse and attachment plugs, which, with the exception of metal parts, are made entirely of porcelain. A large assortment of porcelain insulators and Hercules and Laclede batteries were also shown.

MISCELLANEOUS.

Instruction by correspondence was well discussed at the booth of the International Correspondence Schools, of Scranton, Pa. The booth was well illuminated, showing various samples of students' work.

Probably one of the most attractive spots in the exhibition was the space of the Electrical Engineer Institute of Correspondence Instruction, New York. This is not due to any surpassing artistic arrangement, but to the fact that this enterprising institution had equipped its booth as a popular electrical laboratory, and nightly experiments and demonstrations were given by Mr. J. Sachs. A large number of experiments of the most interesting and instructive nature were shown, and the freely distributed book gave the layman a very clear idea of the so-called mysterious electrical manifestations and applications. Mr. Sachs also gave lectures under the auspices of the institute in the concert hall three or four times each week. The crowds around the booth seemed to show that the layman, electrical artisan, and even in some cases the electrical expert, wishes to know more than he does about electricity. Many new students were enrolled.

The Edison products were well taken care of by the Edison Electric Manufacturing Company of New York. The exhibit included Edison fan motors for battery and electric light circuits, Edison medical transformers for direct and alternating current, and a general line of electro-medical apparatus. The orginal Edison phonograph was also exhibited at this space, with the very latest improvements. Phonograph concerts were given at intervals in the concert hall, and always brought a large attendance.

Some artistic and novel electric lighting appliances and fixtures were shown by the Faries Manufacturing Company, Decatur, Ill. Their universal lamp holders, shades and window display fixtures attracted much attention, and engineers were much interested in the Faries boiler tube cleaner. The Manhattan Electric Storage Battery Company, New York, manufacturers of the Manhattan electric lamps supplied from storage battery, also had an exhibition in this space.

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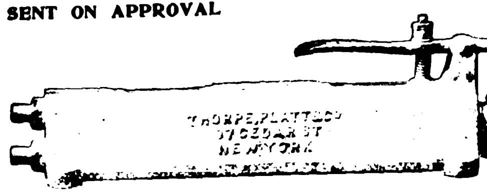

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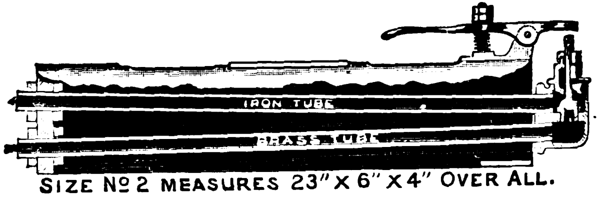

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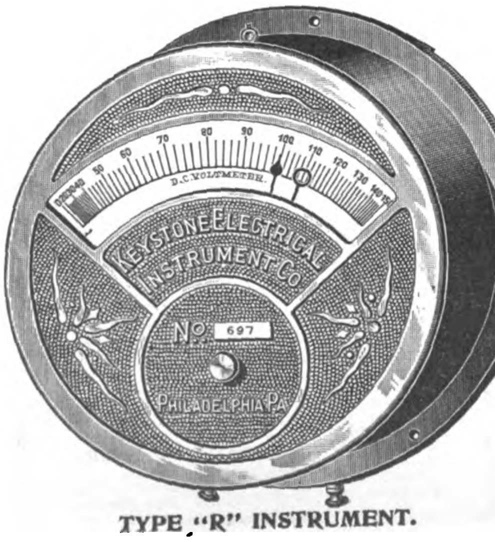

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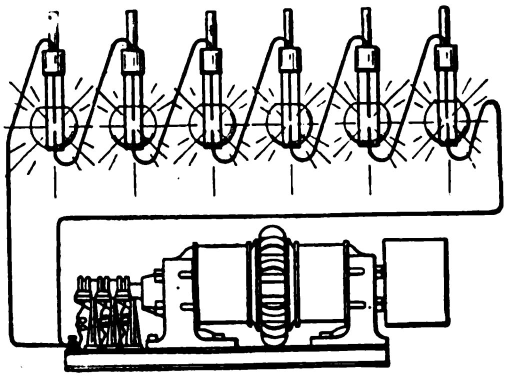

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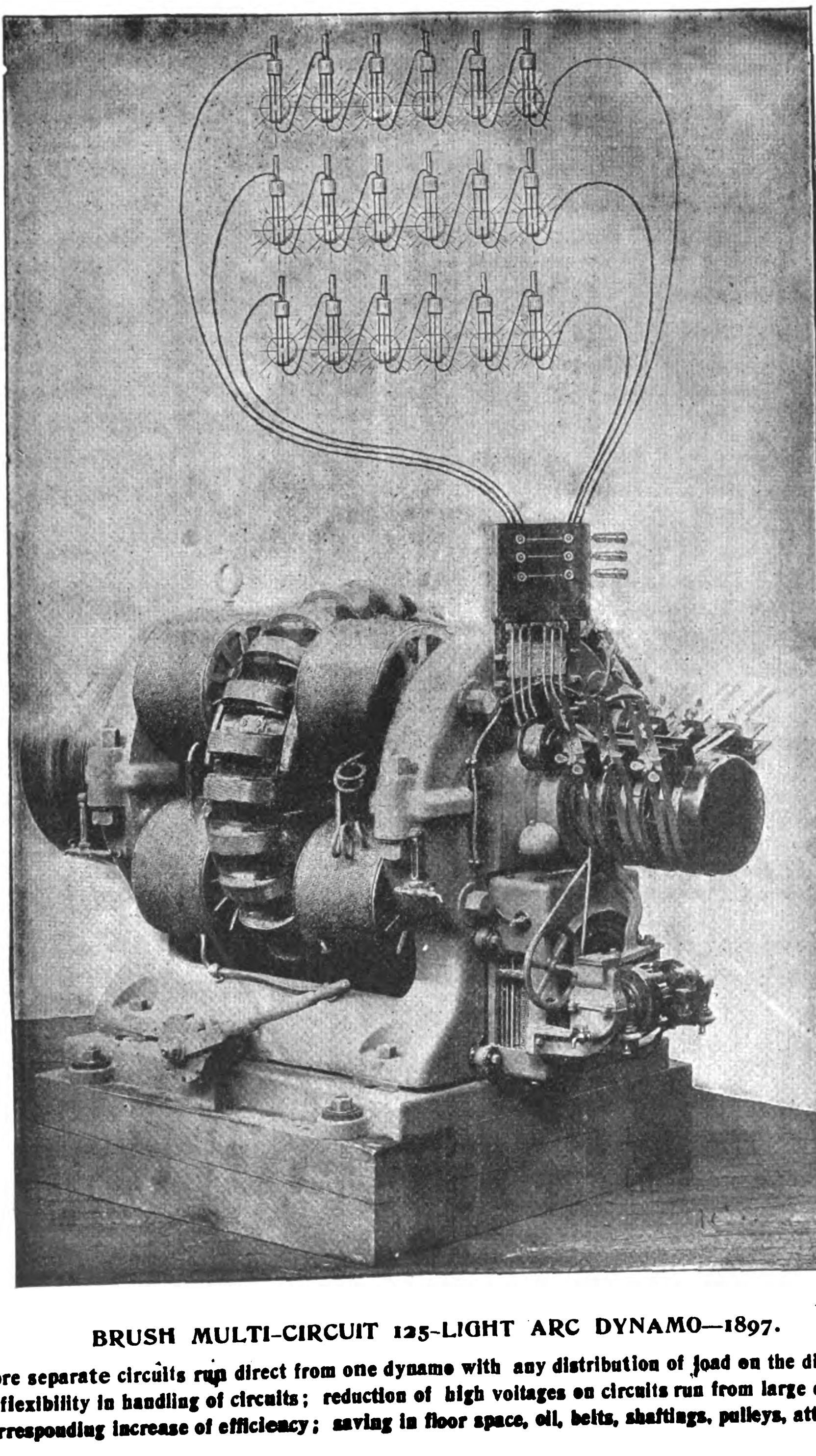

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Toronto	900
Harrisburg	750
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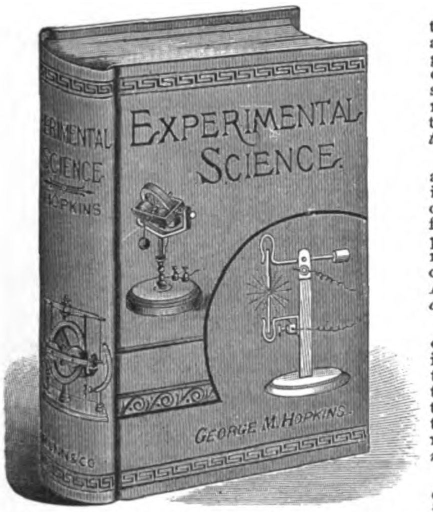

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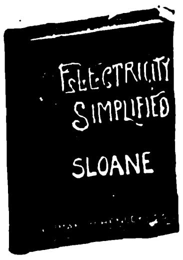

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American Electrician.

Vol. X. New York, July, 1898. No. 7.

AN ELECTRIC RAILWAY STORAGE BATTERY PLANT.

THE BUFFALO RAILWAY COMPANY'S STORAGE BATTERY PLANT.

The Buffalo Railway Company has recently installed in its Niagara Street power house a large storage battery for the purpose of regulating the fluctuating load due to the 300 or more cars operated from that point, to carry the peak of the load, and to serve as a reserve of power in case of the failure of the supply from Niagara Falls. The station contains steam generating units of a total capacity of 7000 h.p., and four rotary transformers, each of about 500 h.p. capacity. These are fed with alternating current at 25 cycles per second from the transmission lines of the Niagara Falls Power Company, and deliver direct current at 550 volts to the railway circuit.

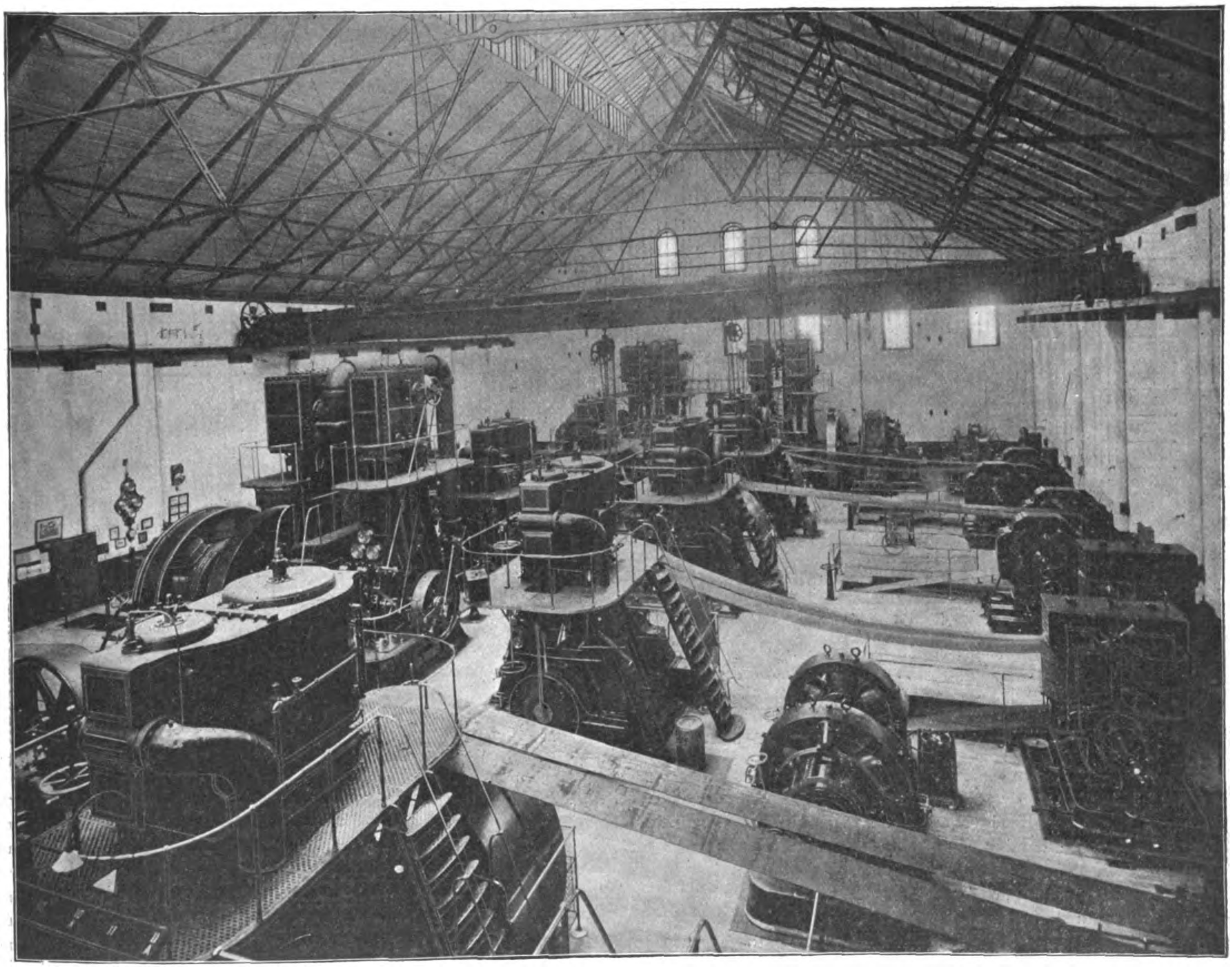

FIG. 1.—VIEW OF GENERATING ROOM.

The power station of the Buffalo Railway Company is an interesting example of electric railway development. It was built early in this decade, when its equipment consisted of 300-h.p. cross compound, high speed engines, each belted to a 200-k.w. Edison bi-polar generator. The next equipment was 200-k.w. Thomson-Houston four-pole machines, and the next General Electric 800-k.w. generators, direct connected to vertical engines. The final additions to the station before the introduction into Buffalo of Niagara Falls power, consisted of three of these vertical direct-connected units. A general view of the interior of the station is given on this page, in which these three types of machines are shown, and with them, in the farthest right hand corner may be seen two of the four 500-k.w. rotary condensers receiving power from the Niagara Falls circuit, and used to supplement the steam plant.

The storage battery consists of 270 cells of the "chloride" type, having a present capacity of about 1200 h.p. when discharged in one hour. As may be seen from the illustration, the cells are not completely filled with plates, but room has been left for the enlargement of the battery by the addition of extra plates, the ultimate capacity of the tanks being for plates sufficient to give 2000 h.p. at one hour's discharge. The tanks for the battery are made of ash, dovetailed together and lined with sheet lead. Heavy porcelain insulators mounted on wooden skids support the tanks, the whole resting on the concrete floor of the battery house. This is a one-story brick building, having a concrete floor and plastered ceiling, the roof being supported on iron columns. The floor slopes gently to one side for drainage, and ventilation is accomplished by means of roof openings and windows. Wooden car mats are laid in the aisles between the rows of cells as an insulation.

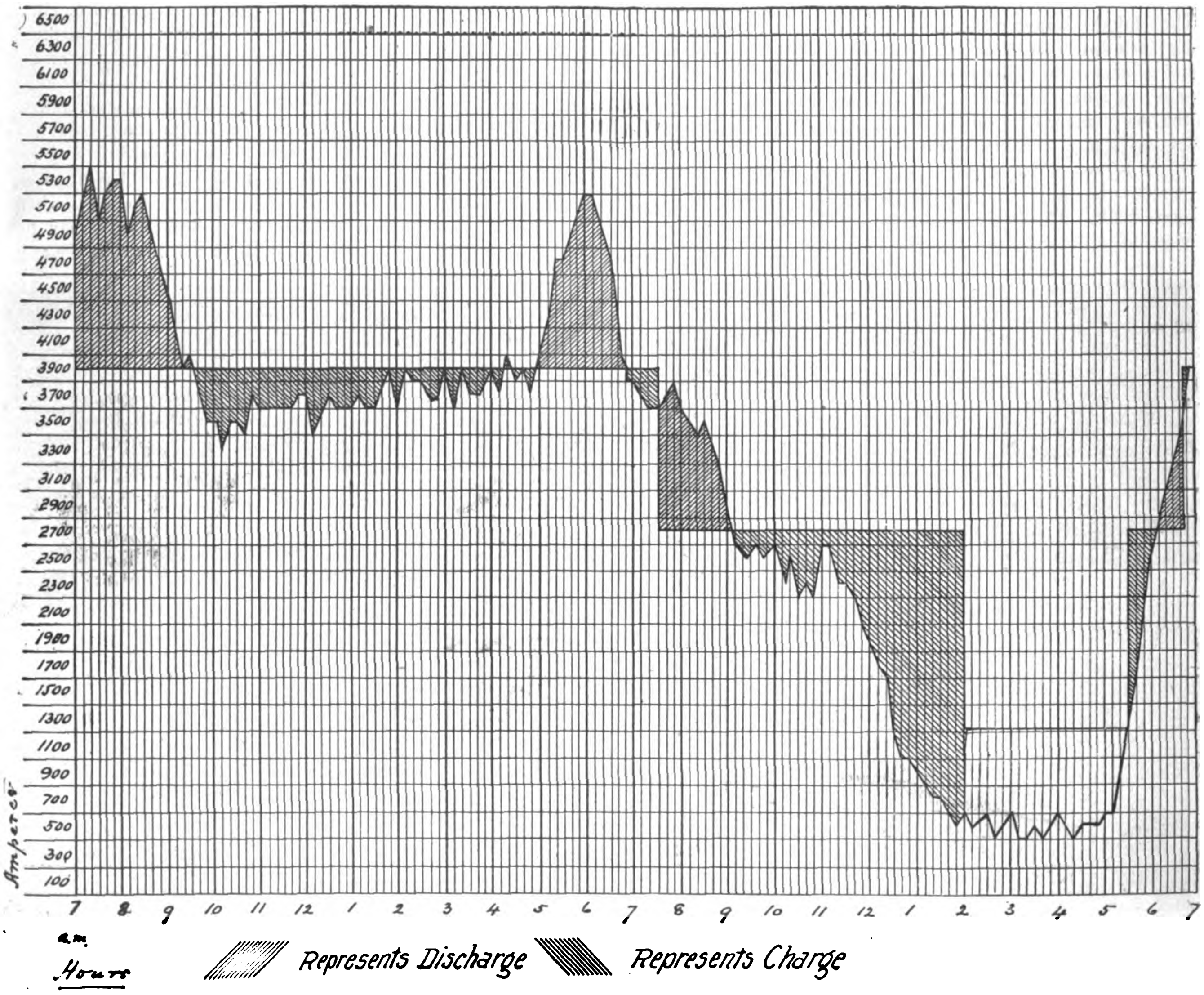

FIG. 2.—CURVES OF CHARGE AND DISCHARGE.

As the illustration shows, all the cells are in one tier and on one level, and the arrangement of the conductors is the simplest possible. All the conductors are of copper covered with lead by a process which results in a thin and firm coating. No trouble has been experienced so far from the gases and spray due to heavy charge rates, and the men working about the battery seem to suffer no inconvenience from them.

The battery is connected at its positive terminal to the main positive bus of the station, and at its negative terminal through a motor-driven booster, having a capacity of 2500 amps. at 70 volts to the ground. The functions of this booster are various, and its construction worthy of special attention. The motor end is an ordinary 6-pole type of motor, working at 500 r.p.m. from the main bus-bars. This is direct coupled to the compound wound booster, which has two commutators of very large size, each carrying six sets of eight brushes. By this arrangement currents as large as 3000 amps. have been sent through the booster without undue sparking. The machine is provided with a center bearing and the usual self-oiling arrangements, and is, as the illustration shows, of very solid mechanical construction.

As the booster is used sometimes to assist the charging of the cells, and sometimes to help their discharge, it is necessary to vary its terminal voltage from zero to a maximum in either direction. This is done by varying the e.m.f. at the terminals of the shunt winding by means of an ingenious switch. In the central position of the switch the e.m.f. at its two points of contact with the resistances is the same, and no current flows in the shunt. At either of its terminal positions the shunt is actuated by the full 550 volts, the direction of its magnetization depending on the position of the switch. The booster can thus be set to either charge or discharge the battery, or in the position of neutral action, by turning the switch lever on the battery switchboard.

During a 24 hours' run the battery is fully charged by the rotary transformers at night and is switched in for service about 5:30 A. M. The peak at 8 A. M. is taken by the battery, which then runs practically as a regulator until the evening peak comes on. At about 7:30 P. M. the steam engines are shut down and the rotary transformers carry the load until the engines are started again at about 6:30 the next morning. Before the installation of the battery it was not possible to shut down the engines except from 11 P. M. until 5 A. M., when the load falls off to about 600 h.p. With the battery it is possible to shut down the engines and run on the rotaries alone for 12 hours in each 24, and for 18 hours on Sundays, while the engines are operated on a constant load while running—the condition of highest economy. During the night all four rotaries in the station are kept fully loaded charging the battery, except from 2 to 5 A. M., when two of them are shut down and the battery cut off to give an opportunity to clean the booster and the rotaries. At these hours the two rotaries that are left running carry the whole load.

When the battery is completed by the installation of the remaining plates it will effect a still further reduction of the steam power consumption and add materially to the economy of the station.

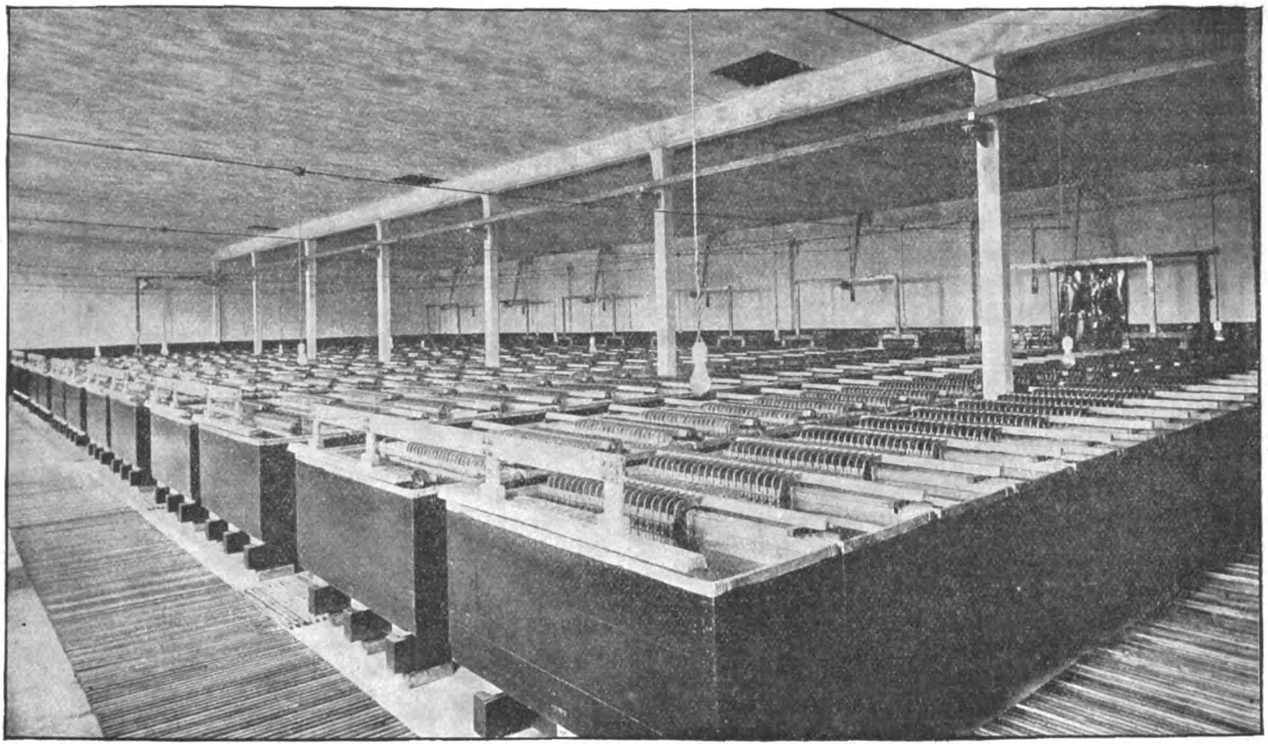
FIG. 3.—STORAGE BATTERY ROOM.

This installation possesses a peculiar interest in being the first and largest user of Niagara power. The current is received as three-phase alternating current at 11,000 volts and 25 cycles per second and transformed to two-phase at the proper pressure for rectification by the rotary converters. In connection with the storage battery this system of supply is almost ideal for its flexibility and closeness of regulation. The voltage at the station does not vary more than 2 to 3 per cent under the extreme and sudden variations of load due to the exigencies of railway service, and shows a steadiness that would be regarded as excellent in a lighting station.

The storage battery was built and installed by the Electric Storage Battery Company, of Philadelphia, and the booster was furnished by the Western Electric Company, of Chicago.

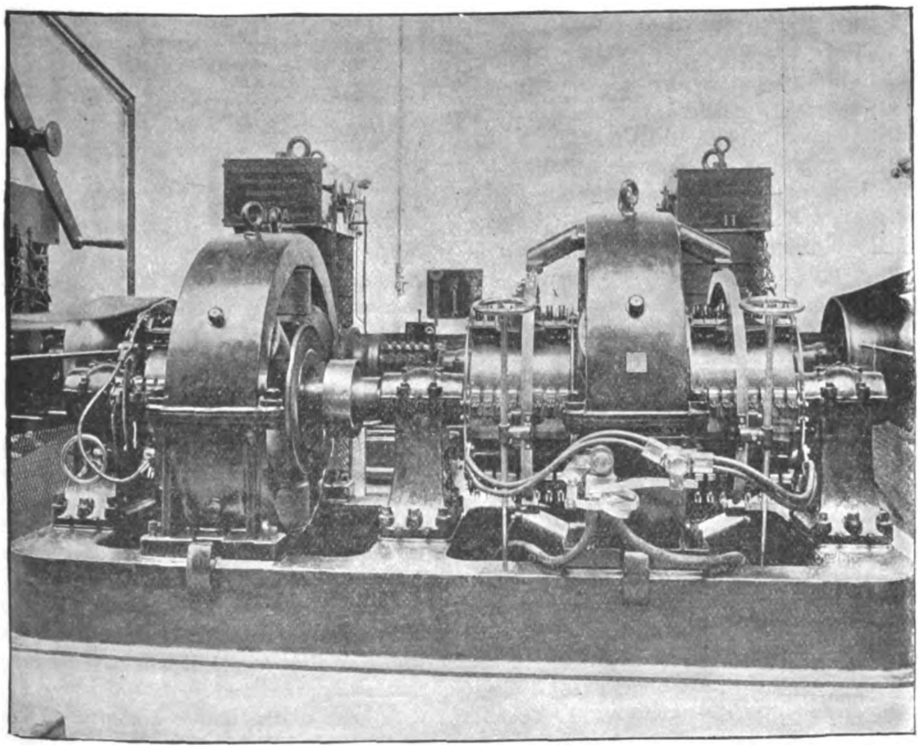
FIG. 4.—MOTOR DRIVEN BOOSTER.

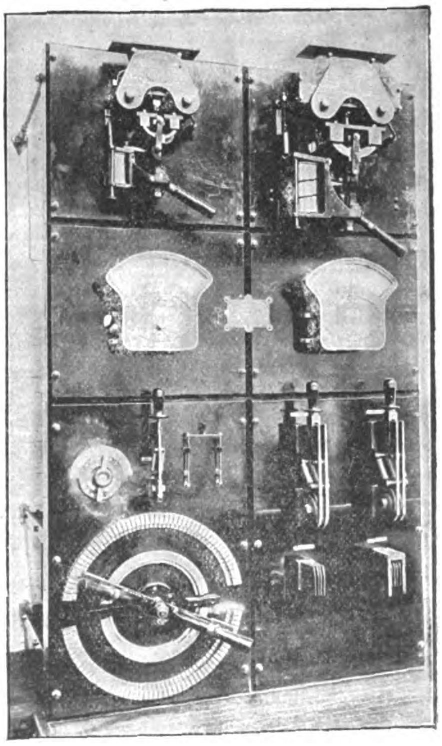
FIG. 5.—TWO PANELS OF SWITCHBOARD.

"SCIENCE ABSTRACTS."

The high promise contained in the first number of "Science Abstracts" is more than fully borne out by the subsequent issues of this valuable monthly publication. The fifth number, or that for May, contains 130 abstracts, and though the publication is devoted to general physics, light, heat and electrical science, the latter subject occupies no less than fifty-six of the seventy pages comprised, the heads being electricity—electro-chemistry and chemical physics—general electrical engineering—dynamos, motors and transformers—power distribution, traction and lighting. The publication is issued under the direction of the English Institution of Electrical Engineers and the Physical Society of London, with Mr. J. Swinburne as honorary editor and Mr. W. R. Cooper as managing editor. Among the committee of seven in charge are Profs. Ayrton and S. P. Thompson, Mr. J. Swinburne, Mr. R. E. B. Crompton and Capt. W. de W. Abney, all well known names in electrical science. The list of abstractors comprises fifty-one names, all men of standing as scientists or engineers. The publications from which abstracts are made comprise the leading scientific and engineering periodicals of the world, as well as the transactions of the various learned bodies of Europe and America. Much attention is given to engineering literature, and the abstracts, more frequently than otherwise, refer to matters of practical interest. As an exhaustive epitome of the advance of physical and electrical science the world over, this publication is invaluable.

POWERING SMALL CRAFT.

DETERMINATION OF THE POWER, DIAMETER AND PITCH OF SCREWS TO PROPEL SMALL BOATS.

We frequently receive inquiries concerning the power necessary to propel small craft of given dimensions, and asking information as to the proper diameter and pitch of screws for the same. There have been no reliable data on these points in print, and in view of the evident need for such data, a high authority on the subject was applied to, who very kindly furnished the information embodied in this article. The data concerning screws are of particular value, being the result of recent experimental work.

The shape of a boat and the relation of its length to the speed have so much influence, that no absolutely definite rules can be given for determining the power, much depending upon judgment in choosing the value of the constant K given in the formula below.

In order to simplify the calculations as much as possible, we give the Admiralty horse power displacement formula[*] in the following form:

$$H = \frac{AB}{K} \text{ .... } (1)$$

in which H is the horse power required. The value of A, corresponding to the weight of the boat fully loaded, is taken from Table I. For example, if the weight of the boat and all its contents at normal load is 4000 lbs., the value of A is 1.47. The value of B is taken from Table II. and corresponds to the speed in statute miles per hour. For example, if the speed is to be nine miles per hour, the value of B will be 477.

Table I.—Values of A.

Weight, lbs.	A	Weight, lbs.	A
500	.397	12.000	3.05
1,000	.584	13,000	3.23
1,600	.765	14,000	3.39
2,000	.926	15,000	3.53
3,000	1 21	16,000	3.71
4,000	1.47	17,000	3 86
5,000	1.68	18,000	4.04
6,000	1.93	19,000	4.16
7,000	2.13	20,000	4.30
8,000	2.33	21,000	4.44
9,000	2.53	22,000	4.58
10,000	2.71	23,000	4.72
11,000	2.88	24,000	4.86

For selecting values of K, no very exact rules can be given, and much must be left to the judgment. In general, the value will depend on three things—length, speed, and form. Other things being equal, it will be greater as the length is greater, less as the speed is greater, and greater as the form is finer. The values for small craft, as here considered, and at ordinary full speeds, are usually from 100 to 150, while as the length becomes greater or speed relatively less, the value increases, until in large ships at proportionately moderate speeds, values from 250 to 300 are reached.

Table II.—Values of B.

Speed, Miles.	B	Speed, Miles.	B
5	84	12	1,131
6	141	13	1,439
7	225	14	1.798
8	335	15	2 212
9	477	16	2,686
10	655	17	3,216
11	872	18	3,818

The influence of length and speed on the problem lies in the relation of the one to the other. As a general guide, it will perhaps be safe to say that so far as length and speed are concerned, speeds in miles per hour not greater than the square root of the length in feet may be considered as moderate and as warranting the higher values of K. Thus, if the length is 50 ft., a speed of 7 miles per hour would be moderate and a value of 150, or perhaps even more, might be used. As this speed is exceeded, the value must be decreased in order to provide for the relatively greater amount of power, and with a fairly fine form it may be expected to come down to 100 or thereabouts for speeds about twice the square root of the length in feet or, in the present case, for a speed of about 14 miles per hour. For a 25-ft. boat the two corresponding speeds would be about 5 and 10 miles respectively.

The influence of form on this value must also not be forgotten. Two aspects of form must be considered, the relation of length to breadth and the degree of longitudinal fullness. The narrower the boat for her length and the finer the form longitudinally, the greater the value of K, and vice versa.

To determine the diameter and pitch of the screw involves the trial solution of the two following formulas:

$$p\,N = \frac{88\,(\text{speed in miles per hour})}{(1 - s)} \quad (2)$$

$$H = \left(\frac{d}{10}\right)^2 \times \left(\frac{P\,N}{100}\right)^3 \times k\,l \text{.......} \quad (3)$$

where H=indicated horse power determined from formula (1); d = diameter of screw in feet; p=pitch of screw in feet; N = revolutions per minute; k = a factor depending on the slip, taken for Table III; l = a factor depending on the ratio of the pitch to diameter of screw, taken from Table IV.; s = apparent slip of the screw—apparent slip being the ratio of the distance moved over to the distance which the screw would travel were there no slip. Owing to the fact that the screw may work in water following a boat, the apparent slip is usually less than the real slip in the water engaged by the screw.

Table III.—Apparent Slip Factors.

App. Slip.	k	App. Slip.	k
.10	.28	.24	.42
.11	.29	.25	.43
.12	.30	.26	.43
.13	.31	.27	.44
.14	.32	.28	.45
.15	.34	.29	.46
.16	.35	.30	.47
.17	.36	.31	.47
.18	.27	.32	.48
.19	.38	.33	.48
.20	.39	.34	.49
.21	.39	.35	.50
.22	.40	.36	.50
.23	.41	.37	.51

Table III. is for screws with four blades of oval form, and having an actual area of about .35 of disk area. For three blades of the same form, the value of k should be multiplied by .85, and for two blades, by .65.

Table IV.—Pitch Ratio Factors.

Pitch Ratio.	l	Pitch Ratio.	l
.90	.941	1.14	.707
.92	.917	1.16	.692
.94	.893	1.18	.677
.96	.872	1.20	.663
.98	.850	1.22	.650
1.00	.830	1.24	.636
1.02	.810	1.26	.624
1.04	.792	1.28	.611
1.06	.773	1.30	.599
1.08	.756	1.32	.587
1.10	.739		
1.12	.723		

There is little reason for expecting any marked variation in efficiency with change in the number of blades, and the selection of this feature is largely a matter of fancy. It may be noted, however, that for given power, speed, pitch-ratio and slip, the less the number of blades the greater the diameter and the less the revolutions. We have here, therefore, a means for assisting in the adjustment of the diameter and revolutions to any desired values, as discussed below.

As an example we will take the case of a boat 34 ft. long and having 7 ft. beam, the speed to be 10 miles per hour. Not knowing the weight, it will have to be calculated approximately.

A boat of the above dimensions would most probably have a draft of 18 ins. and a displacement coefficient of about .5. That is, the volume of water it would displace is equal to the product of the length, beam and draft, multiplied by .5; or volume $= 34 \times 7 \times 1.5 \times .5 = 178.5$ cu. ft. As the weight of one cubic foot of fresh water is 62.5 lbs., the above volume corresponds to a displacement of 11,156 lbs., which displacement is equal to the weight of the boat and its contents when drawing 18 ins. If salt water, the weight is 64 lbs. per cubic foot.

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[*] The Admiralty formula is $H.\ P. = \frac{D^{\frac{2}{3}}\,S^3}{K}$, where D is the displacement in tons of 2240 lbs., and S the speed per hour in knots of 6080 ft.

In regard to the values of the displacement coefficient, the following considerations may be noted.

The values for small pleasure craft are usually found between .35 and .50. In rare cases of very full or bluff forms, the value may rise to .55 or .60. In selecting a value attention should be paid to the fullness in both the longitudinal and the transverse direction. If the form is fine and sharp longitudinally, and if there is considerable rise amidships from the keel outboard, the coefficient will be quite low, probably between .35 and .40. If the form is fine longitudinally, but the bottom is rather flat from the keel outboard, making a rather full midship section, the value will probably be found from .40 to .45. About the same values may also be expected with a form less fine longitudinally, but with considerable rise to the bottom, while as the form becomes more full, either transversally or longitudinally or both, the value of the coefficient will rise to the higher limits.

It must be especially noted that these coefficients relate to the boat without the keel. The draft used must therefore not include the keel, or if, as given, the keel is included, the latter must be subtracted. The volume of the keel may then, if desired, be computed separately and added to that of the main portion of the boat.

From Table I. we find that the value of A in formula (1) corresponding to 11,000 lbs. is 2.88; and from Table II. we find the value of B corresponding to 10 miles is 655. As the form of the boat is rather full as indicated by the displacement coefficient .5, the value of K will be taken at 100. Substituting in (1), we have

$$H = \frac{2.88 \times 655}{100} = 18.9, \text{ or say } 19 \text{ H P.}$$

To determine the dimensions of the screw, let us assume a slip ratio of 20 per cent, or .20. Then since the speed is 10 miles per hour, we have from formula (2)

$$pN = \frac{10 \times 88}{.8} = 1,100.$$

Next, we will assume that the diameter is to have the same value as the pitch—that is, the pitch ratio will be 1—which gives (Table IV.) .83 for l; from Table III. we find that the value of k corresponding to an apparent slip of .20 is .39. Substituting these three values in (3), we have,

$$19 = \left(\frac{d}{10}\right)^2 + \left(\frac{1,100}{100}\right)^3 \times .39 \times .83$$

$$\text{or, } \left(\frac{d}{10}\right)^2 = .0441$$

from which we find $d = 2.1$ ft., or 25.2 ins.

Since the pitch ratio is 1, the pitch will be the same as the diameter, or 25.2 ins. Also, since the value of pN is 1100, we have $pN = 2.1 \times N = 1100$; whence we find N, or the revolutions per minute, to be 524.

If the above propeller is considered too large or the speed too low for an electric motor, we may try a higher slip and a lower pitch ratio, or .25 for the former, and .9 for the latter. The value of k is therefore .43, and of l, .941.

From formula (2) we therefore have,

$$pN = \frac{10 \times 88}{.75} = 1173.$$

From formula (3) we have

$$H = 19 = \left(\frac{d}{10}\right)^2 \times \left(\frac{1,173}{100}\right)^3 \times .43 \times .941$$

or $\left(\frac{d}{10}\right)^2 = .0291$, and $d = 1.71$ ft., or 20½ ins. Since the pitch ratio is .9, the pitch (p) is $.9 \times 1.71 = 1.54$ ft., or 18.5 ins.; and since $pN = 1173$, the revolutions per minute are 762.

In the selection of a value of the apparent slip, s, the following considerations should be borne in mind:

For the best efficiency it is desirable to use values from .15 to .20. Larger values will result in a loss of efficiency. The loss, however, is not large until excessive values, such as 35 or 40 per cent, are reached. On the other hand, the larger the slip the less the diameter for given power and the higher the revolutions for given pitch-ratio. It may thus become necessary to use large values of the slip in order to reduce the diameter, or to increase the revolutions, as may be desired. While such a course is, therefore, open to the designer, it must not be forgotten that it entails a loss of efficiency rapidly increasing, as values above .30 or .35 are reached. A control over the resulting values of the diameter or revolutions may thus be exercised through the slip, but due regard should be had to the efficiency, and values greater than .25 should not be used unless special circumstances warrant a sacrifice of efficiency to other ends.

The values of the pitch ratio commonly met with in craft of the kind we are now considering are usually not far from 1, slightly more or less. From the fundamental equation it may be seen that the less the pitch-ratio the less the diameter with a given slip, and hence the less the pitch and the greater the revolutions for given speed. The diameter and revolutions may, therefore, be modified by an approximate variation of the pitch ratio, as well as by modifying the value of the slip, and between the two, such values of diameter and revolutions as are desired may usually be obtained, unless the conditions are such as to prevent their realization within the range of usual practice.

As a further illustration of the above principles, we will take the case of a boat 30 ft. long, 5 ft. beam and having a draft of 2 ft. in salt water, the speed to be 7 miles per hour. The displacement volume will then be,

$$30 \times 5 \times 2 \times .4 = 120 \text{ cu. ft.};$$

consequently, the weight will be

$$64 \times 120 = 7680 \text{ lbs.}$$

From Table I. we find, by interpolation, that the value of A which corresponds to 7680 lbs., is 2.27; and from Table II., the value of B which corresponds to 7 miles, is 225. Assuming a value of 110 for K, and substituting in formula (1), we have

$$H = \frac{2.27 \times 225}{110} = 4.64.$$

Selecting a slip of .25, and substituting in (2), we have,

$$pN = \frac{7 \times 88}{(1 - .25)} = 821$$

Taking a pitch ratio of 1, and four blades, from Table III. we have $k = .43$, and from Table IV., $l = .83$. Therefore, from (3)

$$4.64 = \left(\frac{d}{10}\right)^2 \times \left(8.21\right)^3 \times .43 \times .83$$

$$\left(\frac{d}{10}\right)^2 = .0235, \; d = 1.53$$

Consequently, the diameter of the screw is 1.53 ft., or 18.36 ins. Since the pitch ratio is 1, the pitch is also 18.36 ins., and since $pN = 821$, the revolutions per minute are 537.

If the pitch ratio were .9, we would have

$$4.64 = \left(\frac{d}{10}\right) \times \left(8.21\right)^3 \times .43 \times .94$$

$$\left(\frac{d}{10}\right)^2 = .0208, \; d = 1.44$$

The diameter is thus 1.44 ft., or 17.3 ins.; the pitch, $.9 \times 17.3 = 15.6$ ins.; and the revolutions, $821 \div 1.44 = 631$.

If we take three blades, we shall have for $s = .25$, a value of $.43 \times .85 = .365$, and consequently for a pitch ratio of .9,

$$\left(\frac{d}{10}\right)^2 = .0245$$

which will give a diameter of 18.8 ins., a pitch of 17 ins., and 582 revolutions.

Suppose one has a boat which it is wished to equip electrically. The first thing to be determined is what displacement is available for the motor, battery and fittings. This may be done by taking out all unnecessary weights and finding the weight in men to bring her down to the smallest permissible freeboard. If there is steam machinery aboard the weight of this, of course, must be estimated and added to the available weight.

With the displacement thus found, calculate as above the horse-power at the desired speed.

In Table V. are given the approximate weights of a type of slow-speed boat electric motor, made by the Riker Electric Motor Co., Brooklyn.

TABLE V.

WEIGHTS OF SLOW-SPEED SERIES MOTORS.

H. P.	Revolutions.	Weight.
1,200	1,200	80
1,000	1,000	140
1,000	1,000	175
800	800	250
600	600	625
400	400	1,100

A storage battery cannot be procured in the market that will weigh less than 100 lbs. per horse-power hour. If, for example, the horse-power calculated is 4.64, this should be increased about 10 per cent to account for motor losses (part of which may be considered as allowed for in the value of the horse-power calculated, which takes into account shaft and engine friction). This gives 5.10 h.p. of battery, or 510 lbs. for each hour the boat is under way, or sufficient for a run of 7 miles. If it is desired to have a capacity for 5 hours' run, about 2500 lbs. of battery will thus be required.

The voltage of the motor will depend upon the type of battery selected. In the above case, if the cells weigh 100 lbs. apiece, the number will be 25, giving a voltage of 50 and a discharge rate of about 75 amps.

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COMMERCIAL DYNAMO AND MOTOR TESTING.

BY W. H. RADCLIFFE.

It has become an established fact, that any one to make a success of electrical engineering at the present time must have a thoroughly practical as well as a theoretical knowledge of the subject. The testing-room of any electrical company manufacturing generators, motors, etc., affords an excellent opportunity for one to become familiar with the handling of machines, their defects and remedies, and the many details that are so valuable in after practice. It is the object of this paper to give a general outline of the work connected with a course such as most of the large electrical companies offer to a man who is fortunate enough to be admitted, and a few of the most important points that will come within his notice.

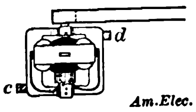

FIG. 1.—LINING A MACHINE.

Assuming that a machine to be tested is brought to a room properly fitted up for that purpose, before it can be lined up it must be fitted with a pulley of such a size that when belted to the testing machine permanently installed, both will be able to run at their rated speeds. A few turns of the belt will show if the machines are in line, after which two blocks of wood nailed to the floor, as shown at c and d in Fig. 1, will be all that is necessary to keep the machine in place.

After the fittings, that is, the brush-holders, brushes, etc., have been attached, the brushes may then be set and weighted; in other words, adjusted to the commutator and given the proper pressure, which should be no more than is actually necessary for a good contact, as too much pressure raises the temperature of the commutator bars. If carbon brushes are used they are then sandpapered to present a smooth surface to the commutator. The motor or generator, whichever it may be, is then ready to be wired for testing.

If the machine is a direct-current shunt motor, readings of volts armature, amperes armature, volts field, amperes field and speed are taken at no load and full load, maximum field strength being given the motor during the entire test. A four-hour heat run at full load then follows, readings as above being taken every half hour. At the end of the heat run, a no-load reading is again taken, the machine shut down and temperatures obtained of armature, commutator-bars, field spools, leading and trailing pole-tips, bearings, frame and room. A core-loss reading—that is, a reading of volts armature and amperes armature of the motor with belt off and running at the same speed and field current as in the last heat run reading—completes the test. Resistances of armature and field are measured before and after every test.

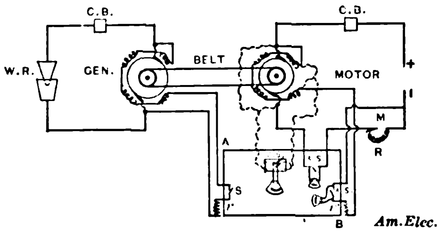

FIG. 2.—TEST OF DIRECT CURRENT SHUNT MOTOR.

In Fig. 2 is shown a diagram of the wiring necessary for the above. A B represents the testing-table on which the ammeters and volt-meters are joined into circuit, as are also the regulating resistances, r and R, in the fields of the two machines. Both ammeters and voltmeters are so arranged as to be cut out of circuit when not in use by means of switches A S and V S, respectively. The voltmeter switch, V S, is double-pole, double-throw, and by means of this volts armature and volts field may be read on the same meter. Switches marked S are main switches and are used to open and close the circuit; M being the motor starting switch, introduces a resistance, R, which it gradually cuts out in closing. W R represents an adjustable water resistance; and C B circuit breakers, one of which is placed in each armature circuit. The above notation also applies to the wiring diagrams that follow.

In testing a series motor, we have a machine which must of necessity be loaded at all times to keep it from speeding up. In this case, the heat run, temperatures after heat run and core-loss reading, are all that can be recorded. The core-loss reading may be taken by separately exciting the series field with the same current the machine takes at full load, the voltage across the armature being varied until the rated speed is obtained.

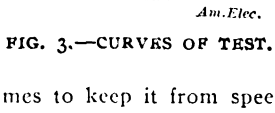

FIG. 3.—CURVES OF TEST.

The wiring for a series motor is the same as shown in Fig. 2, with the exception of the field circuit. As the current in the series field is the current in the armature, and the "drop" of the series field is very low, the wiring in Fig. 2 for volts field and amperes field is not here necessary.

In referring to direct-current generators, let us take for example the commercial test given a compound-wound machine, as we will then have all the characteristics of a series or shunt-wound generator, combined with the compounding.

This test may be divided into four parts—the cold test, heat run, compounding test hot, and the hot test. The first reading in the cold test is of volts armature, amperes armature, volts field and amperes field, with normal speed at no load and full shunt field strength, the brushes being at the neutral point. The second reading is values of the above at no load, normal voltage (brushes at full load position); and in the third, at full load, full series field strength and shunt field as in second reading. The fourth and last reading of the cold test is at full load with a German silver shunt across the series field; the current in the shunt field being given the same ratio to the full load volts as existed between the current in the shunt field and no load volts, in the second reading. A four-hour heat run with this adjustment is then made, readings as above being taken every half hour. The machine at the end of this time is shut down and temperatures taken as in the previous cases. It is then compounded as follows:

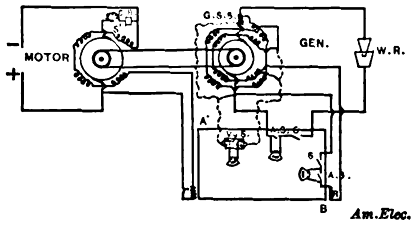

FIG. 4.—TEST OF DIRECT CURRENT COMPOUND GENERATOR.

First, a no load reading at normal voltage is taken, speed, as usual, being kept normal. Next, a full load reading with the German silver shunt so adjusted across the series field as to give full load normal voltage, with the same resistance in shunt field as in previous reading. The readings following are at ¾, ½, ¼, 0, ¼, ½, ¾ and full load, respectively, the load being varied by varying the resistance in the armature circuit.

The curves plotted from these readings take the form shown in Fig. 3. The difference between the volts at no load, that is, between A and C, vary between 3 and 5 per cent; while at full load, between B and D, the difference is usually less than 2 per cent—the rise each time, of course, being due to residual magnetism in the field. There are but two readings taken in the hot test, both at no load; the one, with shunt field adjusted to give one-half no load volts; the other, with maximum shunt field, the brushes in the latter case being moved to the neutral point. The resistances measured during the test are of series field, shunt field and armature, cold; series field, shunt field and armature after heat run; shunted series field, and series field alone, after compounding.

The wiring for a compound-wound generator is shown in Fig. 4, r, the resistance in the motor field is used in keeping the speed constant. G S S represents the German silver shunt. The rest of the notation being the same as in Fig 2, no further explanation is necesssary.

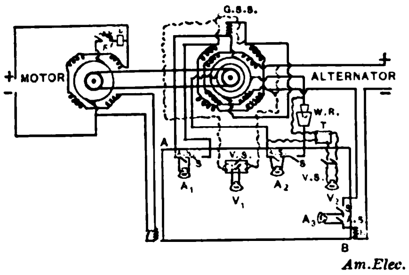

FIG. 5.—TEST OF ALTERNATOR.

The commercial test on any alternating current generator is as follows: Cold test, readings of volts armature, amperes armature, volts separately excited field, amperes separately excited field, volts series field, amperes series field, with normal speed at no load and maximum current in separately excited field. The next reading is values of the above at no load, normal voltage; then a reading at full load, maximum resistance in rheostat shunting series field and the same current in separately excited field, as in the previous reading.

The current in the separately excited field is now adjusted to give full load normal voltage, with the series field shunted as above. A six-hour heat run is made under these conditions, readings being recorded every half hour. The temperatures taken at the end of the run are of armature core surface, armature core vent ducts, armature coils, armature binding wires, armature spider, commutator bars, collector rings, leading and trailing pole tips, separately excited field, series field, bearings, frame and room.

The compounding test hot consists of readings of volts armature, amperes armature, etc., at no load, normal voltage; then full load on each successive step of rheostat shunting series field. In the hot test, readings are taken at full load, normal voltage, also at no load, current in separately excited field, as in the previous full load reading. Resistances are measured before and after test, of the armature, separately excited field, series field and of rheostat shunting series field.

In Fig. 5 the necessary wiring is shown. At A_1 we obtain the direct current in the series field taken from the commutator, i, of the alternator; at A_2, the direct current in the separately excited field; at A_3, the alternating current taken from the collector-ring, c_1, of the alternator; at V_1 the voltage across series field and the voltage across separately excited field; at V_2, the alternating voltage across the collector-rings stepped down through transformer, T.

The commmercial test on induction motors is, first, power required when running light, i. e., with belt off, the readings recorded being volts, amperes and speed. Next, maximum output of the motor, in which readings of volts, amperes and speed of motor, together with volts armature, amperes armature, amperes field and speed of generator are taken just before the motor "breaks down" from overload. A four-hour heat run at full load then follows; volts, amperes and speed of motor, together with temperatures of frame and room being recorded every half hour. Temperatures of the following parts are taken after the heat run: Field lamination surface, field conductor's surface armature spider, bearings, frame and room. Counter-torque readings are then obtained by running the load machine as a motor, belted to the induction motor on open circuit. The first reading is of volts armature and amperes armature required with the same field current and speed as used on the load machine when taking the motor's maximum output. The second reading is of volts armature and amperes armature required with the average field current and speed, as used on the load machine during the heat run. The third and fourth readings are taken under the same two conditions with the belt off. By adding the watts lost in counter torque, with belt on, to the maximum output wattage and to the heat run wattage, we obtain the true power of the motor in each case.

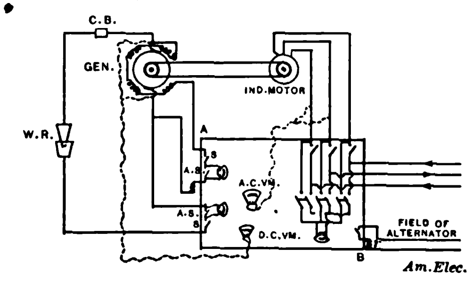

FIG. 6.—TEST OF INDUCTION MOTOR.

The diagram of connnections for this test is shown in Fig. 6. By the arrangement of switches shown at right of table in the alternating circuit, the current in each of the three legs can be measured on the same meter, by closing the double-pole switch and opening the single-pole switch in that leg. The voltage across any of the three legs being the same, an alternating current voltmeter connected across any two of the legs is sufficient. This voltage is kept constant during the entire test by the varying resistance, r, in the field of the alternator. For counter-torque readings the only change necessary in the wiring is in the armature circuit of the generator. This is opened at any point and attached to the supply circuit. The water resistance is used as a starting rheostat for the generator, now to be run as a motor, and is afterward adjusted to obtain the desired speed.

The resistance of the field of the induction motor is measured before and after testing. All machines should receive an insulation test at 500 volts and a high potential test many times in excess of their normal voltage before leaving the room.

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THE INDUCTION MOTOR.

BY ALFRED E. WIENER.

STRUCTURE OF INDUCTION MOTOR.

When a copper core is pivoted within a rotary magnetic field, formed by a number of equal coils placed at equal angular distances around a cylindrical field-core and traversed by either two or three alternating currents of phase-differences of 90 deg. or 120 deg., respectively, it will be dragged into uniform rotation by the reaction of eddy currents induced in its mass by the revolving magnetism. Since, however, currents induced in a solid core always take the path of least resistance, their direction is not necessarily that which causes the greatest reactive effect. In order to compel these currents to yield their maximum influence for the production of rotative force, the copper core must be suitably subdivided into a number of separate conductors, short-circuited amongst themselves, and placed perpendicular to the direction of the field-flux as well as to the direction of rotation.

The currents induced in these conductors are proportional to the intensity of the magnetic flux producing them, and since the flux is the greater the smaller the magnetic reluctance of its path, it follows that the strength of the induced currents can be increased by reducing the reluctance, the latter being accomplished by surrounding the conductors by a mass of soft iron, laminated in the direction of the magnetic flux. Thus by imbedding a system of short-circuited copper conductors into slots formed in a laminated iron core, as shown in Fig. 1, the maximum reactive effect of the induced currents is obtained and a powerful turning force, or torque, is the result.

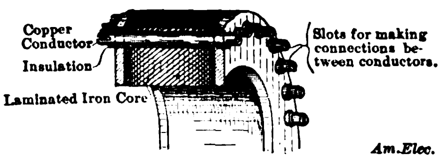


FIG. 1.—STRUCTURE OF INDUCTION MOTOR ARMATURE.

An electric machine which for its rotative power depends upon this reaction, upon a revolving magnetic field, of currents induced by this field itself, is called a *rotary field motor*, or an *induction motor*.

The velocity of rotation of the revolving magnetism depends upon the frequency (number of cycles per second) of the alternating currents supplying the field-winding and upon the number of poles in the field-frame, and can be numerically expressed as 120 times the quotient of the former by the latter quantity. (See Table I.)

TABLE I.
SPEED OF ROTARY FIELD FOR DIFFERENT NUMBERS OF POLES AND FOR VARIOUS FREQUENCIES.

Number of Poles.	Speed of Revolving Magnetism, in Revolutions per Minute, when Frequency is:											
	25	30	33⅓	40	50	60	66⅔	80	100	120	125	133⅓
2	1,500	1,870	2.000	2,400	3,000	3,600	4,000	4,800	6,000	7,200	7,500	8,000
4	750	900	1,000	1,200	1,500	1,800	2,000	2,400	3,000	3.600	3,750	4,000
6	500	600	667	800	1,000	1,200	1,333	1,600	2,000	2,400	2,500	2,667
8	375	450	500	600	750	900	1,000	1,200	1,500	1,800	1,875	2,000
10	300	360	400	480	600	720	800	960	1,200	1,440	1,500	1,600
12	250	300	333	400	500	600	667	800	1,000	1,200	1,250	1,333
14	214	257	286	343	428	514	571	686	857	1,029	1,071	1,143
16	188	225	250	300	375	450	500	600	750	900	938	1,000
18	167	200	222	267	333	400	444	533	667	800	833	889
20	150	180	200	240	300	360	400	480	600	720	750	800
22	136	164	182	217	273	327	364	436	545	655	682	720
24	125	150	167	200	250	300	333	400	500	600	625	667

The speed of the armature, unless power is supplied from without, is always less than the velocity of the revolving field, owing to hysteresis in the armature-core, friction, air-resistance, etc. It is due to the ensuing relative motion between armature and field that lines of force are continually being cut, and that, in consequence, e. m. fs. are set up in the armature conductors. This difference in speeds of armature and field, which is called the *slip*, varies from 40 to 1 per cent of the field-velocity, according to the size and design of the motor. (Table II.)

TABLE II.
SLIP OF INDUCTION MOTORS.

Capacity of Motor, H.P.	Slip, at Full Load, per cent.	
	Usual Limits.	Average.
⅛	20 to 40	30
¼	10 " 30	20
½	10 " 20	15
1	8 " 20	14
2	8 " 18	13
3	8 " 16	12
5	7 " 15	11
7½	6 " 14	10
10	6 " 12	9
15	5 " 11	8
20	4 " 10	7
30	3 " 9	6
50	2 " 8	5
75	1 " 7	4
100	1 " 6	35
150	1 " 5	3
200	1 " 4	25
300	1 " 3	2

While in an ordinary electric motor the armature receives the incoming current from the line, in an induction motor the currents flowing in the revolving part are induced by the action of the rotating field-magnetism and are short-circuited among themselves; hence, no electrical connections between the armature and line are required, and these machines, therefore, have the great mechanical advantage of needing no commutators, collector-rings, contact-brushes or flexible connections.

Owing to the difference in opinion as to which part of a dynamo electric machine should be called its armature—some holding that the field is that part in which the magnetism is fixed in direction while in the armature it changes with respect to the metal mass*, while others have the notion that the revolving part should be called the armature, whereas correctly the armature should be defined as that part in which reaction takes place due to electromagnetic induction, while the field magnet is that part in which are set up the magnetic lines of force, the presence of which causes that electro-magnetic action of the armature—some confusion exists in this respect with regard to alternating current machinery, some forms of them having field frames with stationary, others with moving, magnets, and in still others it is neither the magnets nor the armature, but a separate part, which revolves. In order to avoid misunderstandings as to what part of the machine is meant, in descriptions of alternating current apparatus some writers therefore make the distinction from the mechanical, and not from the electro-magnetical point of view, referring to the stationary part as the *stator*, and to the revolving part as the *rotor*. In the induction-motor, consequently, the field-magnet is the stator, while the armature is the rotor.

The size of an induction motor depends upon the speed desired, and is given by the peripheral velocity of the armature, which ranges between 1000 and 7000 feet per minute, according to the capacity of the motor. In Table III the practical and average values of this velocity are given:

TABLE III.
PERIPHERAL VELOCITY OF INDUCTION MOTOR ARMATURES.

Capacity of Motor, H.P.	Peripheral Velocity, in Feet per Minute:	
	Usual Values.	Average.
⅛	1,000 to 3,000	2,000
¼	1,000 " 4,000	2,500
½	1,000 " 5,000	3,000
1	2,000 " 5,000	3,500
2	2,000 " 6,000	4,000
5	2,000 " 7,000	4,500
10	3,000 " 7,000	5,000
50	4,000 " 7,000	5,500
100	5,000 " 7,000	6,000
200*	6,000 " 7,000	6,500

*And over.

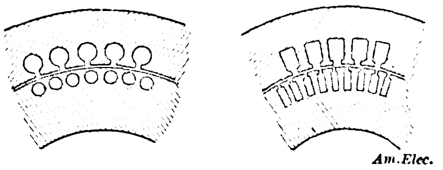
Both the field-magnet and the armature of an induction motor are built up of soft sheet-iron punchings provided with holes, or slots, to receive the windings. Two usual forms of field-punchings and two common varieties of armature-discs are shown in Figs. 2 and 3.

The number of slots in the field-frame depends upon the size of the motor, upon the number of poles and on the number of phases, for, it must be a multiple of the product of the latter two. For motors up to 200 h.p. capacity the number of slots per pole per phase usually ranges from 1 to 5 for three-phase machines, and from 1½ to 8 for two-phase machines. From the following Table IV. the proper number of slots for any particular case can readily be taken:

TABLE IV.
NUMBER OF SLOTS IN FIELD-FRAME OF INDUCTION MOTORS.

Capacity of Motor.	Number of Poles.	Slots per Pole.	Slots per Pole per per Phase.	
			Two-Phase.	Three-Phase.
⅛ H.P. to 1 H.P.	4 to 8	3 4	1½ 2	1 —
½ H.P. to 1 H.P.	4 to 6	5 6	2½ 3	— 2
2 H.P. to 5 H.P.	4 to 10	5 6	2½ 3	— 2
	4 to 6	7 8 9	3½ 4 4½	— — 3
6 H.P to 50 H.P.	6 to 12	7 8 9	3½ 4 4½	— — 3
	4 to 8	10 11 12	5 5½ 6	— — 4
50 H.P. to 200 H.P.	10 to 20	7 8 9	3½ 4 4½	— — 3
	8 to 12	10 11 12 13	5 5½ 6 6½	— — 4 —
	6 to 10	14 15 16	7 7½ 8	— 5 —

According to this table, a 100 h.p. three-phase induction motor, for instance, when wound for six poles, has 5 slots per pole per phase, or a total number of 5x6x3 = 90 slots. If the motor has eight poles, the table gives either 4 or 5 slots per pole per phase, that is, either 96 or 120 slots, respectively. In case of ten poles, either 3, 4 or 5 slots per pole per phase can be taken, making the total number of slots either 90 or 120 or 150, respectively. For twelve poles, the number of slots per pole per phase is either 3 or 4, and accordingly we have 96 or 144 slots. Finally, if the number of poles is greater than twelve, the unit 3 must be employed; hence, in case of 16 poles, for example, we find 3x16x3 = 144 slots.



FIGS. 2 AND 3.—FORMS OF PUNCHINGS OF INDUCTION MOTORS.

In the armature, in order to avoid dead points at starting and to insure smooth action when running, it is important to choose the number of slots such as to make the number of armature conductors per pole per phase prime to the number of field slots per pole per phase. In small motors—up to 5 h.p.—there is usually but one conductor per slot and the winding is usually executed in the "squirrel-cage" fashion, necessitating no consideration as to the regularity of the end-connections; hence, the above condition can be fulfilled by making the number of armature-slots, which in motors up to the size mentioned commonly ranges between seven and nine times the number of poles, any integer not divisible by the number of poles. The slot-numbers thus obtained are compiled in Table V.:

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* See Sylvanus P. Thompson, "Polyphase Electric Currents," p. 113.

TABLE V.

NUMBER OF ARMATURE SLOTS FOR SQUIRREL-CAGE INDUCTION MOTORS UP TO 5 H.P. CAPACITY.

Number of Poles, p.	Limits of Slots-Number, 7 p. to 9 p.	Number of Armature-Slots.
4	28 to 36	29, 30, 31, 33, 34, 35, 37.
6	42 " 54	43, 44, 45, 46, 47, 49, 50, 51, 52, 53.
8	56 " 72	57, 58, 59, 60, 61, 62, 63, 65, 66, 67, 68, 69, 70, 71.

In case of larger motors, which often have two or more conductors in each armature-slot, and in which the winding is connected up in two or more parallel circuits, the number of slots must be chosen a multiple both of the number of pairs of poles and of the number of phases, so that the end-connections are all of the same length, or of as few varieties as possible. The following Table VI. gives armature-slot numbers corresponding to fields having from eight to sixteen slots per pole.

TABLE VI.

NUMBER OF ARMATURE-SLOTS FOR INDUCTION-MOTORS OF CAPACITIES OVER 5 H.P.

Number of Field-Slots per Pole	Number of Armature-Slots. (n_s = Number of Field-Slots).
8	$\frac{5}{4}$ n_s. or ³ n_s.
9	$\frac{4}{3}$ n_s.
10	$\frac{9}{8}$ n_s. or $\frac{3}{2}$ n_s.
12	$\frac{5}{4}$ n_s. " $\frac{4}{3}$ n_s.
14	$\frac{9}{7}$ n_s. " $\frac{3}{2}$ n_s.
15	$\frac{6}{5}$ n_s. " $\frac{4}{3}$ n_s.
16	$\frac{9}{8}$ n_s. " $\frac{5}{4}$ n_s.

They are expressed as multiples of the number of field-slots, and comply both with the last-named condition and with the rule of making the number of armature-slots per pole per phase prime to the number of field-slots per pole per phase. In their selection the possibility of re-using the same armature-disc for different numbers of poles and phases has been had in view.

The height, h_s, Fig. 4, of the field-slots varies from 1 to 1½ times the radial height, h, of the frame, according to the size and design of the motor. Their width (which is determined by dividing the field-circumference by the slot-number obtained from Table IV., and by subtracting, from the result obtained, the thickness of the tooth, the latter, in turn, being given by the condition that the flux-path through the teeth must be of an average area equal to, or greater than, the area of the path in the solid portion of the frame) is ⅛ to ½

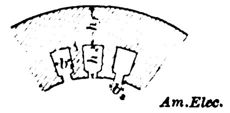


FIG. 4.—DIMENSIONS OF FIELD FRAME.

the height, except in case of circular slots. The width of the opening, b'_s, varies from $.3b_s$ to the entire breadth, b_s, of the slot.

The height of the armature slots usually is between .7 and .9 that of the field slots, while their width, which is found by a process similar to that for determining the field-slot, ranges between ¼ and ½ the height, provided the slot is not a circular one.

The thickness, h_f, of the solid portion of the frame, and the radial depth of the armature core are determined by the requisite magnetic flux and by the flux-density which is best adapted for the case under consideration. The hysteresis loss in iron increases as the 1.6th power of the density, and is proportional to the frequency; and the eddy current loss is proportional to the square of the density and also to the square of the frequency. Hence, in order to avoid an increase of the losses and a consequent decrease of efficiency, accompanied by greater heating, the flux-density in a given motor must be taken the smaller the higher the frequency at which it is to be worked. In Table VII. the practical and average values of the flux-density for motors of various sizes and for different frequencies are compiled:

TABLE VII. FLUX-DENSITIES FOR INDUCTION MOTORS.

Capacity of Motor, HP	Flux-Density, in Lines of Force per Square Inch.					
	For Frequencies from 25 to 40.		For Frequencies from 60 to 100.		For Frequencies from 120 to 180.	
	Practical Values.	Average.	Practical Values.	Average.	Practical Values.	Average.
⅛	12,000 to 18,000	15,000	10,000 to 15,000	12,500	7,000 to 11,000	9,000
¼	15,000 " 25,000	20,000	12,000 " 18,000	15,000	7,500 " 12,500	10,000
½	18,000 " 32,000	25,000	15,000 " 25,000	20,000	8,000 " 17,000	12,500
1	20,000 " 40,000	30,000	18,000 " 32,000	25,000	9,000 " 21,000	15,000
2	25,000 " 45,000	35,000	20,000 " 40,000	30,000	10,000 " 25,000	17,500
5	30.000 " 50,000	40,000	25,000 " 45,000	35,000	11,000 " 29,000	20,000
10	40,000 " 60,000	50,000	30,000 " 50,000	40,000	12,500 " 32,500	22,500
20	50,000 " 70,000	60,000	35,000 " 55,000	45,000	15,000 " 35,000	25,000
50	60,000 " 80,000	70,000	40,000 " 60,000	50,000	17,500 " 37,500	27,500
100	70,000 " 90,000	80,000	45,000 " 65,000	55,000	20,000 " 40,000	30,000
150	80,000 " 100,000	90,000	50,000 " 70,000	60,000	25,000 " 45,000	35,000
200†	90,000 " 110.000	100,000	60,000 " 80,000	70,000	30,000 " 50,000	40,000

† And over.

ARMATURE WINDINGS AND CONNECTIONS.

BY PROF. ARTHUR L. RICE.

FORCED WINDINGS.

The case now to be considered is how to wind an armature which was designed for a multiple-path winding so that it shall have a two circuit winding.

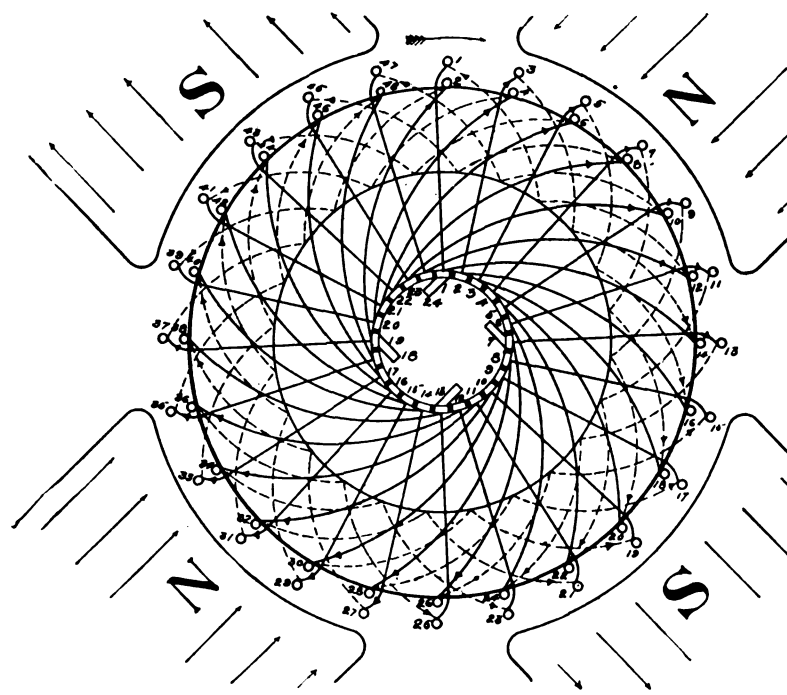


FIG. 1.—FOUR-POLE, DRUM, FOUR-CIRCUIT, LAP WINDING.

Take the case of the armature in Fig. 1; it has 48 conductors wound into a four-circuit armature, with a lap winding; the front pitch is 13, the back pitch 11, which gives a retrograde winding, and the armature is supposed to be of formed coils, laid into slots.

If it be desired to change this to a two-circuit wave winding, the condition is: $48 \pm 2 = 4$ x pitch; 46 or 50 = 4 x pitch; and in neither case will the pitch be a whole number. The number of conductors used must be changed. If one coil, i. e., two conductors, be left unconnected, the utilized conductors become 46 in number; $46 \pm 2 = 4$ x pitch; 48 or 44 = 4 x pitch; and the pitch = 12 or 11. Since for a two layer machine the average pitch must be odd in order to connect from one layer to the other, and also since the coils of Fig. 1 are wound with 11 pitch, it will be best to choose 11 for the pitch both front and back. As but 46 conductors, or 23 coils, are to be used, only 23 commutator bars

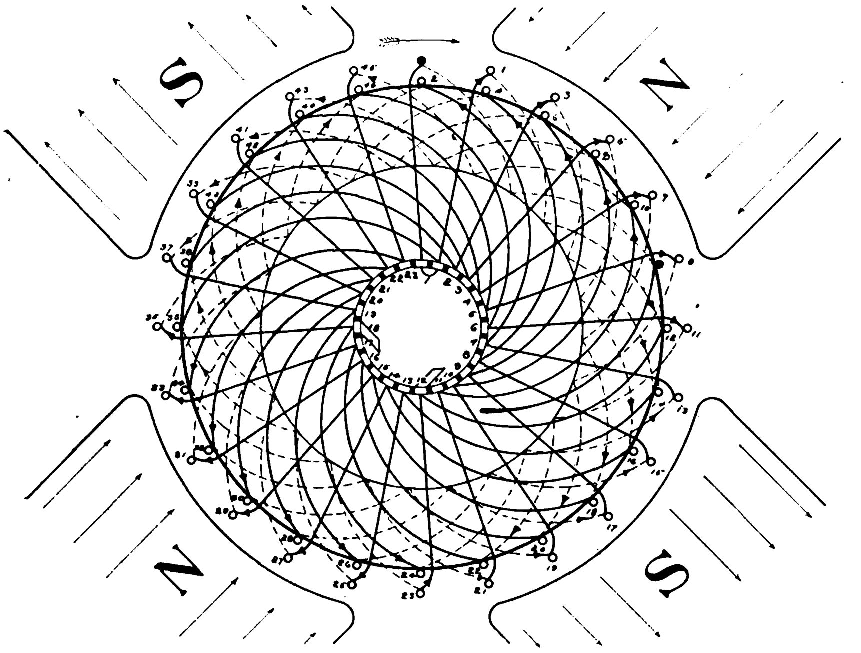


FIG. 2.—FOUR-POLE, DRUM, FORCED TWO-CIRCUIT, WAVE WINDING.

will be needed, so that it will be necessary to leave one bar as well as one coil dead. Obviously, in a formed coil armature, the two conductors to leave unused must be so chosen that they will be sides of the same coil.

It is immaterial which coil is dead ended, and the coil should be put in place, for the sake of mechanical balance, the same as if it were to be used. In Fig. 2 the conductor which would have been No. 1 has been left in the dead coil, so that its number is moved along to the next conductor in the same layer; this makes the numbers come staggered, until the dead wire, 11, ahead, which would have been No. 12 in the under layer is passed, when the numbers catch up and become regular. The bar which would have been No. 1 is short circuited to one of those adjacent; it is of no importance which one, because the dead bar is simply a space filler and becomes really a part of the bar to which it is joined. The connection is then from bar 1 to conductor 1, on the back to conductor 12, on the front to bar 12, thence to conductor 23, to conductor 34, to bar 23 and so on, having connected in four conductors between the two adjacent bars.

It makes no electrical difference what is done with the ends of the dead coil; generally one of them is joined in its regular place in the commutator bar, and that bar is made dead; the other end is doubled back on itself and covered with insulation, as indicated in Fig. 2.

By tracing out the direction of the e. m. fs. the brushes are found to belong on bars 12 and 18 at points midway between poles, as was to be expected. They are at 90 deg., or 6 bars apart; there are four conductors joined in between two bars, as noted above; hence between brushes there are $4 \times 6 = 24$ conductors, about half the active wires on the armature, and the machine will have two circuits as required, though slightly unbalanced.

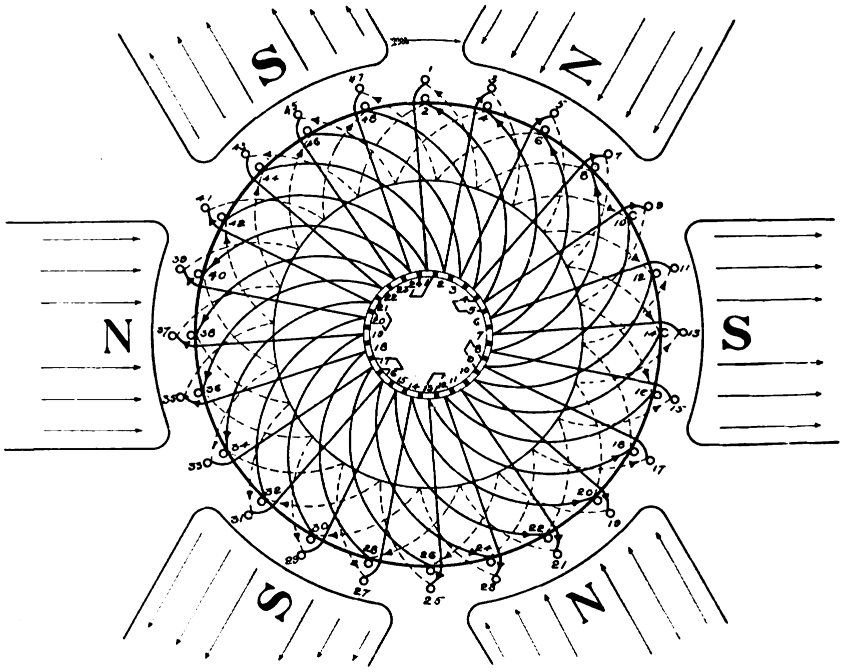


FIG. 3.—SIX-POLE, DRUM, SIX-CIRCUIT, WAVE WINDING.

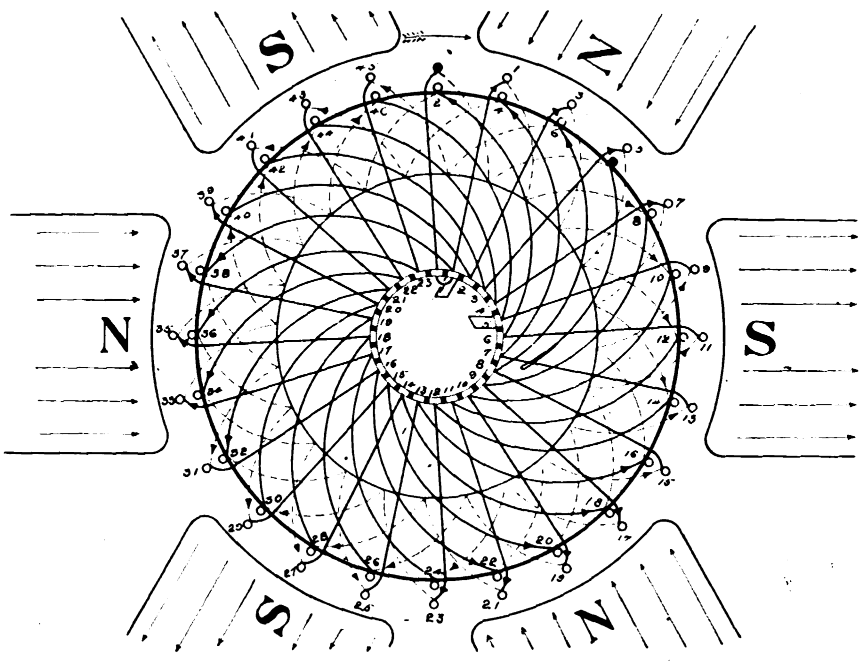


FIG. 4.—SIX POLE, DRUM, FORCED TWO-CIRCUIT, WAVE WINDING.

Suppose a six pole machine, with 24 slots, is to be wound with two layers, first with six circuit armature, second with two circuit. The number of conductors will be $24 \times 2 = 48$; the pitch will be:

$48 \pm 6 = 6 \times$ pitch; 54 or $42 = 6 \times$ pitch; pitch = 8 or 7. Let 7 be chosen so as to pass from one layer to the other. There will be 24 bars to connect with the 24 coils. The connections will be from bar 1 to conductor 1, on back to conductor 8, on front through bar 8 to conductor 15, on back to conductor 22, on front through bar 15 to conductor 29, on back to conductor 36, on front through bar 22 to conductor 43, on back to conductor 2, on front to bar 5 and so on, as shown in Fig 3.

The brushes are found to belong on bars 1, 5, 9, 13, 17 and 21, and the circuit just traced from bar 1 to bar 5 contains eight conductors, one-sixth of the number on the armature, so that the winding is correct.

For the second case the condition will be: $48 + 2 = 6 \times$ pitch; 50 or $46 = 6 \times$ pitch; and no even pitch can be found. But, if two conductors and one bar be omitted, $46 + 2 = 6 \times$ pitch; 48 or $44 = 6 \times$ pitch; and the average pitch can be made 8. This will necessitate using uneven, odd pitches front and back such that the average shall be 8; 7 and 9 are the most natural numbers to use and have the advantage that, if 7 be made the back pitch, the coils can be wound the same as for the first case, and only the connections to the commutator need be changed.

In Fig. 4 the conductor which was No. 1 in Fig. 3, is left dead and the odd numbers moved ahead one wire; the even numbers are the same as in Fig. 3 until No. 8, which was connected to No. 1, is reached, when that one is left dead and the rest of the even numbers are set ahead one place. The bar which was No. 1 in Fig. 3 is short circuited to the one which connects to conductor 1 in Fig. 4. The dead wire in the outer layer is connected to the dead bar and the other end of the coil is doubled back and insulated. The connection runs from bar 1 to conductor 1, on the back to conductor 8, on the front to conductor 17 by way of bar 9, and so on. By the time that bar 2 is reached six conductors have been connected up. The brushes are found to go on bars 1 and 5 at four bars apart, hence there are $4 \times 6 = 24$ conductors in one path through the armature, and $46 - 24 = 22$ in the other. These numbers are about half of the total number of connected conductors, hence the armature will have two circuits, but they will be somewhat unbalanced, as was the case in Fig. 2. In neither case will the unbalancing be serious enough to cause trouble.

NATIONAL ELECTRIC LIGHT CONVENTION

CHICAGO CONVENTION OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION.

The convention of the National Electric Light Association, held at Chicago, June 7, 8 and 9, was in many respects one of the most satisfactory in the history of that organization, though differing both in attendance and the character of the proceedings from other conventions of recent years. Apparently, with increasing years, the association becomes more dignified. At this meeting the exhibits of supplies and the dealers in electrical goods were conspicuously absent, and the lack of their presence detracted somewhat from the usual gayety of the convention. Contrasted with the meeting at Niagara Falls last year, this convention was more business-like, and, though the attendance was smaller, the character of the papers appealed more directly to the managers of electric light stations than the somewhat academic essays read last year.

The success of this convention was in large part due to the character of the subjects discussed, and their important bearing upon the electric lighting industry. A tone of supreme common sense pervaded the discussions, and showed that the business of electric lighting has become conservative in its later years—a gratifying evidence of its solidity.

There were no excursions or entertainments except an enjoyable reception tendered the visiting members by the electrical fraternity of Chicago. The hospitality of the Chicago Edison Company, the Metropolitan West Side Elevated Road, and the South Side Elevated Road, whose stations were thrown open to the visitors, was greatly enjoyed.

No little of the success of this meeting is due to the efforts of Mr. Samuel Insull, the retiring president of the association. As president of the Chicago Edison Company, Mr. Insull is in touch with the central station business in one of its most comprehensive developments. Easily the foremost man in the electric lighting industry in the United States, he was able to show the members the workings of one of the finest systems extant, and to arouse interest in the topics of discussion by his thorough knowledge of their details.

Of the discussions, the most interesting was that following Mr. Rice's paper on the "Cost of the Generation and Distribution of a Unit of Electricity," though the old question of alternating vs. direct-current supply from central stations came in for no small share of attention. Of the papers read all are abstracted here save Professor Goldsborough's on "Transformer Economy."

ALDEN M. YOUNG, PRESIDENT N. E. L. A.

The lecture on "Electricity Direct from Coal," delivered by Mr. Joseph Wetzler on Wednesday evening, was largely attended and greatly enjoyed.

In the election of its officers for the ensuing year the association displayed its usual excellent judgment.

Mr. Alden M. Young, the new president, was born at Hadley, Saratoga County, N. Y., September 6, 1853. After leaving school he entered the telegraph business and was manager for the Atlantic & Pacific Telegraph Company, in 1870, at Fort Plain, N. Y.; in 1871 at Saratoga, in 1872 at Syracuse, in 1873 at Albany, 1874-77 at Buffalo, and in 1878-79 at New York City. In 1878 he went to Connecticut and organized the telephone company at Waterbury, and was its manager for about ten years.

In 1883 Mr. Young became interested in electric lighting, and a little later organized in Waterbury its first and only electric lighting company. In 1892 he obtained a controlling interest in the Waterbury Horse Railroad Company, and in 1893 this company, now the Waterbury Traction Company, absorbed the electric lighting company, and now lights the city of Waterbury and operates the only electric street railway in the city.

In 1890, taking up the private business of Mr. Young, the New England Engineering Company, of Waterbury, was incorporated, for the purpose of installing electric light plants, electric railways and power stations. By this company electric light plants have been installed in Connecticut at Norwich, New Britain, New London, Stamford, Naugatuck, Bristol, Thomaston, Seymour, Branford, Westport, Stafford Springs, Rockville, Putnam, and at Palmer, Mass.; at Poughkeepsie, Catskill, Hudson, Canajoharie, N. Y.; at Paterson, Elizabeth, Dover, Somerville, Morristown and Boonton, N. J., and at other points.

Mr. Young is at present president of the New England Engineering Company, of Waterbury; secretary of the Waterbury Traction Company, president of the Central Railway & Electric Company, of New Britain, Conn.; secretary of the Norwich Gas & Electric Company, of Norwich, Conn., and an officer in a dozen more electric companies in the States of Connecticut, New York and New Jersey.

Within a few months Mr. Young and a number of prominent capitalists organized the Kings County Electric Light & Power Company, of Brooklyn, N. Y. This company is now completing a central station of the most approved and modern type. Mr. Young has always been actively connected with the National Electric Light Association, and last year served as its first vice-president.

Mr. E. W. Rollins, the first vice-president, is largely interested in electric lighting properties in Colorado, and has been for a long time president of the Denver Consolidated Electric Company. Mr. F. A. Gilbert, the second vice-president, is the president and general manager of the Boston Electric Light Company and an officer in many other electrical corporations in the New England States. The executive committee for the ensuing year are Messrs. Samuel Insull, Chicago; Samuel Scovil, Cleveland, Ohio; H. M. Atkinson, Atlanta, Ga., and F. A. Copeland, La Crosse, Wis.

PRESIDENTIAL ADDRESS.

In his opening address President Insull

first discussed the interesting topic of standard vs. special machinery, and pointed out how the user is directly interested in the low cost of production of machinery on the part of the manufacturer. When specifications are made calling for special machinery they convert the factory, in effect, into a jobbing shop, cutting down its capacity, increasing the cost for labor and lengthening the time required to produce a given article. From the manufacturer's point of view the capacity of the plant is reduced and the interest and general expense cost made higher, so that the selling price must be increased or the shop run at a loss.

Continuing upon the subject of standard specifications, Mr. Insull said that the designing engineer who adapts his requirements to the standard apparatus of a first-class manufacturer is able to produce a plant of more satisfactory character and one more economical to operate than if he had been influenced by the desire to use machinery he could claim as his own.

After a general discussion of the subject of rates of charge for the product of the electric light station, Mr. Insull spoke at length on the topic of municipal control and ownership of semi-public industries. Pointing out that self-interest and the necessity of getting a return on the investment are the first essentials to the economical administration of large enterprises, he said:

"While I do not pretend to claim that electric lighting companies are beyond reproach, I wish to point out that many of the evils complained of as pertaining to corporate management are the direct results of the enforcement of unwise conditions through legislative action. Ill-advised efforts are often made by legislative bodies to secure advantages in the direction of control which cannot be obtained without giving an equivalent in protection to the industry. This causes the investor to feel that his property is being attacked and compels him to resist such legislation. The result is a feverish agitation, crimination and recrimination, between the would-be improvers of municipal government and the owners of corporate properties without reaching a conclusion satisfactory to either. The fallacy of the so-called reformer's theory results from looking only at what he calls the injurious effects of corporate management without taking into account its indisputable benefits. He does not seek for the cause of the trouble. If reformers will take accurate account of all the points in the problem they will discover that the evils complained of result from errors in legislation designed to determine the relations between municipal bodies and electric lighting companies. It seems to me that the claim that municipal operation is the universal cure for all diseases for which electric lighting companies are supposed to be responsible merely proposes the substitution of political in the place of industrial management."

Naturally this raises the question whether the political control and administration of affairs in various cities is efficient and economical as compared with the management of private concerns. The misunderstandings that have arisen from time to time between the managers of electric light companies and the communities they serve should disappear if the relations between the two are founded on a basis of public control with corresponding protection to the corporation operating the industry. The idea generally held that competition is the true regulative force which holds down the charges for current made by the companies is not true. Competing companies invariably come together, and the interest cost on their product, far the most important part of its cost, is high both by reason of the duplication of plant and the high rates necessarily paid for money during the period of competition.

Exclusive franchises under proper control furnish the most equitable arrangement for both company and public. Taxing franchises by demanding a percentage of the company's gross receipts is an inequitable way to raise revenue, since the tax is, of course, added to the charge for service by the company, and its customers thus bear the burden of a tax which benefits the whole community. In a proper scheme of public control another point that should not be omitted is a condition making it mandatory upon the community to buy the plant at a fair valuation if it is ever decided to undertake municipal ownership of this industry. Otherwise the inequitable condition of the municipality competing with its licensee who has been led into investing money and developing the business prevails, which amounts to the destruction of private property without compensation in the attempt to secure a public benefit.

In conclusion Mr. Insull said that he would summarize the position that he thought the association would take in just two sentences:

"First—Franchises granted to public service corporations should secure them the same degree of protection in their rights to their property as is enjoyed by other investments.

"Second—Public control of charge for service based on cost plus a reasonable profit, and eliminating the factor of competition, is the proper safeguard for the interests of users, taxpayers and investors."

COST OF GENERATING AND DISTRIBUTING A UNIT OF ELECTRICITY.

The paper read by Mr. Calvin W. Rice on the cost of producing and distributing a unit of electricity does not lend itself readily to abstraction. In discussing the total investment per k.w., Mr. Rice stated that in America the variation of investment ranges from $700 to $200 per k.w., a few plants showing figures outside these limits. In the great majority of cases the cost is below $400. Some railway plants show costs lower than $75 per k.w., but these figures refer to stations alone, while the corresponding figures for lighting stations include distributing plants also.

While great stress is nowadays laid upon efficiency, this is less important than either reliability or good regulation. The latter means the ability to use high efficiency lamps, and the possibility of saving in the lamp is greater than that shown by boilers, engines or dynamos. The value of accessories in the reliability of the plant and the saving in labor and attendance is very important. The waste from steam-driven accessories is often enormous, as figures quoted from a report on the steam consumption of auxiliary apparatus on a U. S. cruiser show.

The distribution system, now that many places require its installation underground, becomes a very great item of expense, and hence no material for its construction not of the most perfect reliability should enter into discussion. Mr. Rice dwelt upon the importance of prolonged tests, using high power and large capacity test instruments.

Comparisons of the cost of operation of plant per unit output per year show that the cost of plant to produce 1 k.w. hour per year is about 50 cents. In this connection the most important point is load factor. A long quotation was made from a paper recently read before an English association giving data upon the influence of the load factor on the total cost of generating a unit. From the tables given another interesting point was brought out, namely, the number of units generated by various plants and unaccounted for. The percentage loss ranges from 5 to nearly 48, and while the majority of this loss is necessary to the distribution, still a large part of it might be saved by due attention to this feature.

An interesting average of the cost of coal and contract price for arc lamps in forty-six States containing about 1000 stations was shown, from which it appears that the average yearly hours of burning were 3326, the average cost of coal $3.03, and the average contract price $101 per year. The average cost per hour is given at $.034 and the light per hour for one cent as 580 nominal c.p.

In conclusion an interesting summary of a number of plants using steam and water power under various conditions was given in the form of tables, which contain much valuable and interesting data.

PUBLIC LIGHTING IN RELATION TO PUBLIC OWNERSHIP AND OPERATION.

In a paper with the above title Mr. Alex. Dow set forth a policy which he regards as the best to be followed by companies engaged in public lighting. He said:

"This paper is written to set before the association a proposed policy. It is not a new policy in its parts, neither is it an untried policy. It is applicable immediately to public lighting; that is to say, to the lighting of streets and public places under contract with, or on account of, a municipality. Ultimately its application may be more extensive.

Mr. Dow then cited the example furnished by the history of electric lighting in the city of Detroit. In February, 1896, the city of Detroit owned 1500 arc lamps, and was operating 1492 of these in the work of street lighting. In the same month the successor of the Brush Electric Light Company, which installed the original twenty-two lamps in 1883, and which, until 1890, lighted the streets under contract, owned 1049 arc lamps, and used in private lighting 433 of that number. Another company, organized in 1890 to compete with the Brush Electric Light Company, owned 1330 arc lamps and was using in private lighting thirty-eight of these. In each case there accompanied the arc lamps a sufficient number of dynamos, engines, boilers, etc., and a building fully equipped for the operation of the number of lamps stated. At the same time the city had in use 134 towers, which had been formerly owned by the Brush Company, and the other company was in the act of taking down and removing from the streets 104 similar towers, which had formed a duplicate of the Brush Company's equipment. The necessary lines to connect lamps distributed over a large city had been owned by all three. The city had in use 329 miles of overhead wires, connecting to its 1492 lamps. Neither of the companies had owned such a great mileage of line, but one had taken down lines and poles which had supplied 719 lamps, and the other was in the act of removing lines and poles which had connected 1279 lamps.

Of all this equipment more than two-thirds is to-day a useless asset. Dynamos that cost $2400 would not now bring $240. In the case of the second company the loss was even greater. Towers that had been erected at great cost had to be taken down and sold for scrap iron. Clearly these conditions, that reduced machinery and lines capable of supplying 2000 arc lamps to their junk value, involved a loss to somebody, and equally certain is it that there was a loss to the community at large. In this case the greater part of the loss was borne by investors in the city of Detroit, and after correcting for the inflation of securities and other affecting causes it amounted to not less than $400,000. It was submitted as a principle not admitting dispute that the duplicating an effective plant is an economic error entailing loss of available capital to the extent of the duplication.

"I submit as a direct application of the principle last stated, that competition for public lighting contracts, for the execution of which there is already an effective equipment in existence, is not legitimate business. The corollary of this statement is that the price at which public lighting is to be performed must be determined by some acceptable means other than competitive bidding. In this there is a departure from the established method of municipalities, which now depend on competition for the setting of prices on all public services performed by contract.

"In the absence of some other acceptable means of setting a proper price for public lighting by contract, public opinion will not tolerate the suppression of competition."

Again referring to the case of Detroit, Mr. Dow showed how the second company coming in secured a three-years' contract for the public lighting. It soon became apparent that the company could not go on beyond the term of three years at the same price, but would have to meet the competition of the original contractor, attempts to combine the two interests failed until the two plants were practically duplicates.

Of course the public became advised of the cessation of competition and the advocates of municipal ownership made the most of the facts and added much fiction. Long before the contract had expired it was plain to any careful observer that it could not be renewed at anything like the former figure and that the tendency of public opinion was strongly to municipal ownership. It was a period of "reform" one of those periods when the taxpayers insist on calling the particular bosses of the hour to an accounting.

The suppression of competition was thus inevitable, since its continuation meant a cumulative loss to those engaged in it. Possibly the public might have been made to see this, but to prove that competition was impossible would not have been enough; it must be further proved by offering good service at an acceptable price that competition was unnecessary. In this way the state of things that resulted in a municipal plant originated and grew.

After reciting the cases of a number of cities where cessions on the part of the contracting companies led to continuance of profitable contract relations, the difference between public and private lighting was taken up. The fact that electric light is the cheapest and best for street lighting, and by no means the cheapest for private lighting, was brought out, and a number of figures of cost of gas and electric light in various cities given. From these figures it was argued that the lighting of the streets in the best way, being a public necessity, is properly a function of the municipality, and the production of this light is a business in which it can rightfully engage at the public expense; but the very nature of electric light makes its private application a luxury enjoyed only by a part of the population.

Of causes tending to the contrary one is that the contracting plant may have little or no private lighting. Some other plant in the city may do all or most of the private business. This condition of affairs can be only temporary, the consolidation of the two plants being an economic necessity certain to arrive in time.

The public believes consolidation against the public interest, but this is an error, and the way to prove it such is to give the public the surplus profits of consolidation in the shape of lower rates or better service—or both.

Among other causes handicapping the contractor is the unwillingness of cities to make long term contracts, but the worst burden the contractor has to carry is excessive capitalization.

Having thus recited his premises Mr. Dow drew the conclusion that the best policy for the association to adopt is the following:

"1. That a municipality may properly provide for public lighting either by the ownership and operation of an electric lighting plant, by the operation of a contractor under lease of a municipally owned plant, or by contract with the owner of a private plant.

"2. That the supply of electric light to private users is not properly a municipal function.

"3. That the performance of public lighting under contract by a private plant in connection with the supply of electric light to private users is essentially the method of least expense.

"4. That the existence of two electric lighting plants in the same territory is an economic error tending to increase the cost of production, and thereby the selling price, and that the maintenance of competition is to the detriment of the public.

"5. That public lighting by contract should be performed at the lowest price consistent with a reasonable profit on the value of the investment; that no electric lighting contractor should demand more than such a profit, and that each municipality should protect the contractor in the enjoyment of his profit, and against impairment of his investment, in order that a minimum profit may become reasonable.

"6. That in order to adjust prices in the absence of competition it is necessary that costs be ascertained and prices approved by a competent authority, acceptable to the public as well as to the contractor.

"7. That in the absence of a constituted authority competent to ascertain costs and prescribe prices, members having public lighting contracts under consideration should endeavor to have the adjustment of the contract price undertaken by a temporary commission, or arbitration committee, who will adopt as the basis of adjustments the principles set forth, particularly in number five above.

"8. That there is no essential difference in the organization of municipally owned plants requiring a different analysis of costs from that which is proper for private enterprises, and that the publication of the costs of municipal lighting plants properly analyzed is beneficial to the electric lighting industry. Further, that the similar publication of the costs of private plants is desirable, but is at present impossible because of its advantages to actual or possible competitors."

GENERAL DISTRIBUTION FROM CENTRAL STATIONS BY ALTERNATING CURRENTS.

Mr. Herbert A. Wagner read a paper with the above title in which he discussed at length the advantages of alternating current distribution for central station work. In introducing the subject Mr. Wagner said:

"I may startle many by stating frankly the discouraging fact, which has been barely whispered at times, that, judged by the standards of the magnificent Edison properties in many of our larger cities, few alternating current central stations in the United States have been a success. The fault lies, not with the alternating current itself, but with its application. Its few apparently inherent deficiencies, such as the difficulties of operating motors and arc lamps, have been shown to have been only awaiting discovery and development, and were at our disposal almost as soon as these important divisions of central-station service were operated with success from the Edison three-wire system. These can, therefore, hardly be held responsible for the difference in the commercial results obtained with the two systems.

After briefly reviewing the methods in general use for the distribution of electrical energy Mr. Wagner made a strong plea for the use of the methods of the Edison three-wire stations in alternating work. The distinguishing characteristics of this system, the use of pressure wires and the feeder and main system, the perfection of detail that has been the result of many years of intelligent effort, are all equally applicable to an alternating system. In the ordinary method of distribution by alternating current, where the pressure is regulated at the bus-bars or by means of a compensator, the line and transformer losses unite to cause variations in the pressure at the lights. With a system employing pressure wires running from the secondaries of transformers located at the ends of the feeders the pressure on the low-tension distributing system could be kept very constant, and the use of individual transformers abandoned. These feeder transformers would be worked at high average load, thus raising the average efficiency and improving the first cost of transformers. By increasing the copper loss and decreasing the iron loss in these transformers their average efficiency may be greatly improved.

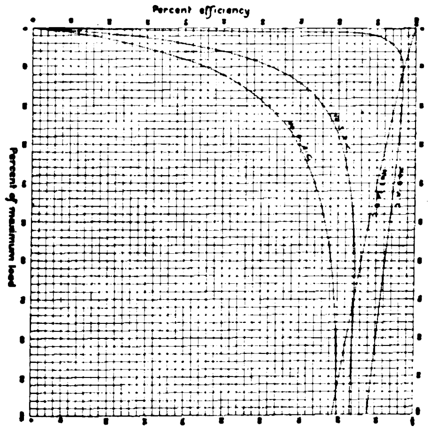


FIG. I.—CURVES OF DISTRIBUTION EFFICIENCY.

"Having provided against any interference with the regulation of the system by the transformer drop, we can afford to increase that to the heating limit of the copper. In this way, a 100-k.w. transformer can be built with an average efficiency of over 98 per cent. The entire transformer loss can, moreover, be more than made up by the less loss in feeders, which we would naturally have with alternating current.

"This system was conceived several years ago, and it has since been my good fortune to have an opportunity to install a system of this kind on a large scale, which is now in very satisfactory operation. It is laid out exactly as a three-wire Edison system would be, except that there are no subfeeders. A network of mains is planned as if for use with direct current. The feeders are all designed for 110-k.w. maximum load at 1100 volts, and at each feeder end is placed a 110-k.w. transformer feeding into the three-wire network in the same manner and at the same points as with the direct current system. The transformers are located in manholes of suitable design. From the secondary terminals of each transformer, pressure wires are run back to the station. Each feeder has an independent regulator by which the pressure can be raised or lowered. There are no primary mains, nor any connection whatever between the primary feeders. The regulators perform two functions. They are used to maintain the proper pressure as indicated by the voltmeters and to divide the load between transformers in any way desired as indicated by the feeder ammeters. It is possible to shift the entire load from one transformer and feeder to an adjacent transformer in this way without sensibly affecting the pressure on the system, and an equal division of load between transformers can be readily maintained at all times if desired. This is a very important consideration when very heavy loads or overloads are to be carried. The distribution of load on any large system is constantly changing as new customers are connected, and in large Edison stations certain feeders often become so overloaded that it is found necessary for their safety to put resistance in series with them to force some of the current to other feeders. The possibility of overloading any individual feeder beyond its share is absolutely provided against in the system described.

In Fig. 1 are shown four curves of station distribution efficiency. No. 1 is that of a representative Edison three-wire, direct-current station. No. 2 is the new alternating current system described. No. 3 is the usual alternating current system employing separate transformers for each customer or for adjacent customers, the best modern transformers being used. No. 4 shows the same system, but with the average transformers found on the lines of most existing stations. These curves were plotted from the following data obtained from actual practice.

	No 1. P. C.	No. 2. P. C.	No. 3. P. C.	No. 4. P. C.
Feeder loss	24	8	10	10
Main loss	2	2	2	2
House wiring loss....	1	1	1	1
Transformer loss, iron	—	.23	6	12
Transformer loss, copper	—	2.7	1	.5
Total loss at maximum station load.	27	13.93	20	25.5
Efficiency at maximum station load...	78.7	87.9	83.3	79.6

The efficiencies of distribution at assumed average loads are shown to be as follows:

P. C.	No. 1. P. C.	No. 2. P. C.	No. 3. P. C.	No. 4. P. C.
Load, 25..................	94.1	95.8	78.4	66.6
Load, 20..................	94.8	96.2	75.3	61.4
Load, 15..................	96.1	96.5	70.3	54.3
Load, 10..................	97.3	96.4	61.9	45.1

At maximum load it will be noticed that the efficiency of alternating current No. 2 is 10 per cent higher than No. 1, the direct current. This means that the same energy can be delivered with 10 per cent less capacity in generators, engines and boilers, or a difference of 10 per cent in the first cost of generating plant. It is pertinent to remark here that alternating-current generators also have a much greater margin for overload for short periods than direct-current generators. The efficiency at average load, or the all-day efficiency of the No. 2 alternating-current system, is also shown to be appreciably higher than the direct-current. In large central stations the average load is generally found in practice to vary from about 15 to 20 per cent of the maximum, and it will be noted that from 12 per cent average load up, No. 2 curve for the special system of alternating-current distribution shows a higher efficiency than the direct-current.

The extension of direct-current systems by the use of alternating-current generators, transformers and rotary converters was then touched upon, and some figures given to show that the same results could be accomplished better by the use of alternating currents throughout. The objections to the use of the alternating current were discussed under the heads of efficiency, regulation, the operation of arc lamps, and motors, the special applications of current, and last but not least, the application of storage batteries to regulate the station load and smooth out any variations in the curves of voltage. In conclusion a method for the operation of series arc lamps from the alternating high pressure mains was outlined and a system in which 2300 arcs are thus operated described.

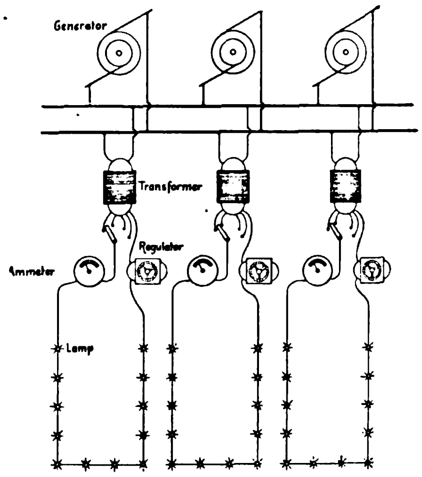


FIG. 2.—ALTERNATING CURRENT SERIES ARC LIGHTING SYSTEM.

"The circuits are each provided at the station with a regular step-up transformer of a maximum capacity of 4000 volts and 10 amps., and the feeders to these transformers are treated on the switchboard in the same way as the feeders for incandescent lighting. It is quite usual for one generator to carry 2000 of these lamps. The lighting is satisfactory to the city and the lamps give better service than when operated by direct current. There has been a very marked saving in fuel and attendance. The i.h.p. per arc lamp is considerably less than with the direct-current arc lamps operated in the usual manner. Fig. 2 shows this system in diagram. In summing up the case for the alternating current Mr. Wagner gave the following list of points of marked superiority of this variety of current:

"Highest possible efficiency of distribution and operation.

"Best regulation.

"Largest territory desired readily supplied from one station.

"Comparatively small cost of feeders, effecting enormous saving in investment.

"Least cost of real estate.

"Cost of installing and operating substations entirely avoided.

"The only system in which all classes of service can be supplied from one type of generator.

"Greatest flexibility."

GENERAL DISTRIBUTIONS FROM CENTRAL STATION BY DIRECT CURRENTS.

Mr. Louis A. Ferguson read a very interesting paper with the above title, the greater part of it being devoted to a description of the station system of the Chicago Edison Company.

Speaking of the general problem of the availability of direct or alternating current for any particular case, Mr. Ferguson said that the trend of engineering opinion and practice to-day is toward the use of the alternating current for the feeding of outlying districts, while the best results have been obtained in the neighborhood of the stations by direct-current distribution.

Proceeding to describe the new system of the Chicago company a number of interesting figures were given, showing the output of the four stations that comprise the system, which is one of great magnitude.

"The total low tension direct current k.w. hours output for the stations for the fiscal year of 1897 was 15,255,466, divided as follows:

	Low Tension Kilowatt Hours.	Per Cent. of Total.
Station No. 1.......	11,335,618	74.3
Station No. 5.......	2,314,473	15.2
Station No. 2.......	808,158	5.3
Station No. 4.......	797,217	5.2
	15,255,466	100.0

	Maximum Station Voltage.	Yearly Average Station Voltage.
Station No. 1.......	149.	126.2
Station No. 5.......	142.5	129.6
Station No. 2.......	125.0	119.0
Station No. 4.......	123.5	120.1

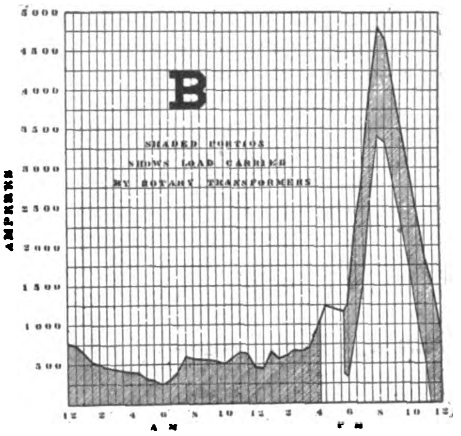
"The pressure at the feeder ends throughout the system is maintained at 115 volts on each side of the three-wire system. Although the maximum station pressure is 149 volts, the average pressure of all stations for the year is 126.2 volts, giving an average loss of pressure of 11.2 volts or 8.8 per cent, which means an average yearly efficiency of distribution of 91.2 per cent from the station switchboards to the customer's meter.

"The center of distribution in the business district of the city is at Adams Street, between Clark and La Salle Streets. Station No. 1, which furnishes 74.3 per cent of the total low tension output, is located 3340 ft. distant from the center of distribution at Adams Street. Station No. 5, which furnishes 15 per cent of the total low tension output, is located 4500 ft. from Station No. 1, and 3000 feet from the Adams Street sub-station.

"These two stations furnish all the low tension output for the district bounded by the river on the north, Harmon Court (approximately) on the south, Lake Michigan on the east and the river on the west. They also furnish all the energy for the entire low tension system of the city during the hours from midnight until dusk the following afternoon, and a portion of the output of districts No. 2 and No. 4, from dusk until midnight daily, and ultimately they will furnish all the output of the territories mentioned, and all of the energy required for alternating transmission lines into the outlying districts of the city and its suburbs.

"The distribution of current from these two stations to the underground network is as follows:

"From Station No. 1 to the Adams Street sub-station is laid an immense trunk line known as the Adams Street trunk line, having a total cross-sectional area of 66,000,000 c.m., 28,500,000 c.m. being ordinarily connected on the positive and negative sides and 9,000,000 c.m. in the neutral. The length of this trunk line is 3340 ft., and is made up of fifteen special Edison tubes, each 3,000,000 c.m. area, laid directly in the ground, and fourteen 1,500,000 c.m. stranded rubber insulated, lead covered and juted cables drawn into cement lined iron ducts. The trunk line on leaving Station No. 1 goes down a shaft sixty feet, thence through a brick tunnel built especially for it in the river bed to the east side, where it rises again in another shaft sixty feet into the tunnel house, where a small switchboard is located. The portion of the trunk line in the shafts and tunnnel, which is 430 ft. in length, is made up entirely of cables. Where the cables hang vertically in the shaft, the cable is supported by the iron armored sheathing clasped between iron plates on a heavy cast iron ring. The copper conductors thus hang in a sort of basket, the strain being distributed throughout the length of the cable. At the tunnel house the cables connect with fifteen 3,000,000 c.m. single-pole Edison feeder tubes, and together with the fourteen 1,500,000 c.m. cables are mounted on racks in a large subway, into which the duct line enters about 200 ft. east of the tunnel house. At intervals of about 500 ft. manholes are built in the Edison tube portion as well as in the conduit portion of the trunk line, thus affording a quick means of locating low insulation points as they develop. Each of the tubes and cables is provided with an amperemeter at Station No. 1, and with switches at both ends so that they may be completely disconnected from the system in case of trouble. Two of the 3,000,000 c.m. tubes are provided with throwover switches and arranged so that they may be quickly connected either to the positive or neutral or negative or neutral at will. All of the cables are provided with throwover switches on both ends, so that they may be operated either as positive or negative at will, thus providing for any possible contingency that may arise. At the Adams Street sub-station the trunk line feeds into the main bus-bar in the distribution room, and from the switchboard forty-two feeders radiate to various points in the business district, ranging in size from 250,000 c.m. to 1,000,000 c.m., and in length from 290 ft. to 2831 ft., the average size being 485,000 c.m., and the average length of feeder 1373 ft.



LOAD DIAGRAM OF CHICAGO SUB-STATION.

"The maximum current in amperes carried over the trunk line and distributed from the Adams Street sub-station last December was 34,400 amps.

"Station No. 2, which is now really a rotary transformer sub-station, is 17,500 ft. from Station No. 1, and 14,300 ft. from Adams Street sub-station. The load diagram "B" shows the amperes delivered to District No. 2, the cross hatched portion representing the current furnished through the rotary transformers and the unshaded portion representing the current furnished by the dynamos in Station No. 2, the dynamos and rotary transformers operating in parallel on the three-wire system. The upper curve shows the total amperes delivered to District No. 2.

"District No. 2 is supplied from Station No. 1 by means of a converse rotary transformer connected to the 250-volt direct current bus-bars, converting to three-phase alternating current at about 160 volts. By means of step-up transformers this is raised to 4500 volts, and at this pressure the energy is transmitted by three-phase underground transmission line to Station No. 2, where it is reduced by step-down transformers to about eighty volts and converted by means of rotary current transformers to direct current at about 115 volts.

"For the permanent conversion of Station No. 2 into a sub-station a pair of special 200 k.w. generators are being installed, directly coupled to the existing 600 h.p. triple expansion engines in Station No. 1. Each generator is provided with a commutator and a set of three collector rings, and are designed to deliver from the same armature direct currents and three-phase alternating currents, the direct current sides of each pair of machines being connected in series to form a three wire unit, and the alternating current sides, after passing through transformers stepping up to 4500 volts, being connected in multiple. The alternating current from these machines will be taken to supply the transmission line to Station No. 2, and the balance of the capacity of the machines will be delivered directly into the main direct current bus-bar of Station No. 1, thus keeping the unit operating at full load and maximum efficiency during its run.

"Uniformity of pressure throughout an incandescent electric lighting system is absolutely essential to commercial success.

To accomplish this different methods have been proposed at different times. It often happens that the original plan of distribution, laid out by the constructing engineer, does not meet the requirements, after several years' growth of the business, for in all cities lighting business may localize at certain special points, and so demand a remodeling of the existing system of conductors, or require some means of correcting for the inequalities of pressure that are due to the unevenly distributed load."

After describing the underground system in vogue with the Edison companies, he said:

"The parallel operating of the generators greatly simplifies the maintaining of uniform pressure regulation at the lamps, since when several units are connected to the common bus-bars the regulation for the entire system may be effected by careful attention to one unit, whereas in alternating current stations where the generators do not operate in parallel it is necessary, in order to even approach the uniformity of pressure regulation which exists in direct current systems operating in parallel, to regulate the pressure accurately on each unit, which is seldom done in practice. Besides the better regulation possible with parallel operating of the dynamos, a further distinct advantage is derived from the economy effected by proper division of load among the units in the stations, this being particularly marked when the distribution systems are also interconnected. Each unit, irrespective of size, may be usefully and efficiently employed at the period of maximum load, and the amount of idle or uneconomically employed investment is reduced to a minimum."

The same ground taken by Mr. Wagner in the paper above was further elaborated by Mr. Ferguson. The engineer expecting good regulation and its consequent advantages must follow the lines indicated by the experience of the large city central stations, whether direct or alternating current be used.

"One of the advantages to be derived from the use of direct current distribution as distinct from alternating current distribution, is the employment of storage batteries. They may be adopted for use in various ways, in sub-stations in outlying districts where the load factor of the district is very small, in the central stations themselves to deliver the entire output during period of minimum load, at the centers of distribution for discharging during the peak, as auxiliaries in rotary transformer sub-stations for discharge use at the time of the maximum load in the main central station. In addition to any one of the various ways which the battery may be employed, it always acts as a reserve, guaranteeing the consumer good service, in much the same manner as a bank surplus is a guaranty to the depositors in cases of financial emergency.

"Batteries are economically valuable in connection with the distribution of direct current in systems whose load curve has an average peak width of not more than two hours, since the investment required for storage batteries to carry the peak having an average width of less than two hours is less than the investment required in steam and electrical machinery to do the same work. The storage battery also has the same value that exists in the case of moving machinery as a reserve in meeting sudden increases of load, provided such increase of load does not continue for a sufficient period to wholly discharge the battery and insufficient time remains for recharging before the ordinary load peak of the system appears at the regularly appointed time.

"The steam and electrical machinery is rated by the h. p. or k. w. and the duration of the load peak does not influence the value of the investment since the machinery may be operated for the full twenty-four hours at its maximum capacity. The storage battery, however, is rated by the h. p. hour or k.w. hour and the investment is nearly directly proportional to the number of hours during which it discharges the maximum capacity, so that if we required the battery to be prepared to carry the full peak prolonged for seven or eight hours every day the investment in battery would be enormous as compared with steam and electrical machinery to furnish the same k. w. hours output.

"The storage battery has a very distinct value, which is seldom recognized and employed to its full advantage, when located at the central distributing point of a system with feeders radiating to various points in the network. The battery may be provided with two or more end cell switches, so arranged that they may be connected in multiple and feed into the main distributing feeder bus, or, they may connect also to one or more auxiliary bus-bars with a different number of cells in series, feeding into each bus thus providing two or more potentials at the center of distribution. It will be found that when only one pressure is maintained at the center of distribution during the time of maximum load of a large district that the pressure at the ends of the short feeders will be somewhat higher than the standard and they will be overloaded, and at the end of long feeders the pressure will be lower and the feeders underloaded, although the pressure variation at other times may be negligible. Under such conditions the storage battery becomes exceedingly valuable, for by arranging it to operate at two or more potentials, the long feeders may be connected during the time of maximum load to the auxiliary bus or buses and additional current forced over them, utilizing their full capacity and maintaining a uniform feeder end pressure by means of an investment in end cells very slight as compared with the investment in additional feeders and mains required to accomplish the same result.

In conclusion Mr. Ferguson stated that it was his opinion that the useful field for alternating current distribution is not in large cities, but rather in the scattered suburban districts and in small towns where commercial lighting, elevator service and power forms but a small part of the demand and where the first cost of the direct current system would be prohibitive. The successful central station of the future will be one intelligently combining the use of the two kinds of current.

COST OF PRODUCING ELECTRIC POWER BY WATER POWER FROM THE LACHINE RAPIDS, CANADA

In a paper having the above title Mr. W. McLea Walbank gave some interesting figures of the cost of generating electric power at the great Lachine Rapids installation near Montreal. The hydraulic installation is one of great magnitude and cost in the neighborhood of $1,000,000. As the head is low, vertical shaft turbines were used, six being geared to each of twelve dynamos of 750-k.w. each, generating three-phase current at 4400 volts. Of the total installation forty-eight wheels are already in place, and the head and tail races, dams, etc., and the power house are completed. The transmission line is about 5 miles long, the current being received at a sub-station where it is stepped down to 2300 volts for distribution.

"In estimating the cost of producing power from the Lachine Rapids, the writer does not take into consideration the cost of distributing power, for this would be the same in either case, whether the prime mover was a water wheel or a steam engine. He will therefore confine himself to the cost of developing water power and delivering that power on the bus-bar at the sub-station, exclusive of the generator. He will add the cost of transmission line from the source of power to the sub-station in the city, because this is directly attributable to water power plants.

"There will also be included the step-down transformers to bring the pressure equal to that required for local distribution, namely, in the neighborhood of 2000 volts.

"He will also charge the water power with the drop or loss in power from the rapids to the sub-station.

"The writer therefore considers, in justice to the Lachine Rapids plant, it would be necessary to give, first, the cost per k.w. per year for the portion of the plant at present installed and connected to generators ready for operation, and, second, what the cost will be per k.w. per year when the whole water power development is in operation.

"First—The total cost of water rights, dams, hydraulic machinery, power house, transmission line, step-down transformers, etc., is $957,200.

"Power developed, 4000-k.w. at the generator. Allowing 10 per cent loss, there will be delivered at the substation bus-bar 3600-k.w., which is equivalent to $263.83 per k.w., capital cost.

This, at 6 per cent., would be equivalent to	$15.96 per k.w.
Depreciation of $300,000, which will more than cover the cost of that portion of the plant subject to depreciation, rated at 5 per cent and spread over 3,600 kilowatts, would be equivalent to	4.17 per k.w.
Operating expenses, including labor, repairs, insurance, amounts to $10,275 per annum, which, divided into 3600 kilowatts, is equivalent to	2.85 per k.w.
Making a total cost per kilowatt on a 24-hour day basis, per year....	$22.97 per k.w.

"Second—The total cost per kilowatt with the whole water power plant in operation.

"Before giving these figures the writer would like to explain that the figures herewith quoted are reliable for the cost of the completed plant, inasmuch as the same is at present under contract with reputable firms.

"The total capital cost with seventy-two wheels installed will be $1,113,273.

Power developed after deducting all losses will be 13,500 k.w. at the sub-station bus-bar, equivalent to $82.46 per kilowatt capital cost, which, at 6 per cent., represents (per annum)................	$4.95 per k.w.
Depreciation per kilowatt will equal	1.68 per k.w.
Operating expenses, including labor, repairs, oil and waste and insurance, if taken upon the same basis as already existing, will amount to $20,453, equivalent to	1.51 per k.w.
Making a total for a 24-hour run per annum of................	$8.14 per k.w.

From the foregoing the writer trusts that he has shown that where reliable water power can be obtained within reasonable distance from power centers it can be made to produce cheap electric current, to say nothing of the great advantages the city must derive therefrom, not only commercially, but viewed from a sanitary standpoint as well, as the use of electric power thus generated is the best smoke consumer yet invented.

It will be noticed that the operating expenses, as well as the depreciation per k.w., in the latter case is very much reduced, and it is a remarkable feature how constant our operating expenses are, even at present, being practically the same with full load as with no load.

In connection with these figures it might be stated that coal used in Montreal and vicinity is what is known as Nova Scotian coal, and costs $3.50 per ton for run of mine.

REPORT OF COMMITTEE OF STANDARD CANDLE POWER FOR INCANDESCENT LAMPS.

This committee, of which Dr. Louis Bell is chairman, reported as follows:

Your committee has been able to have tested in the most careful manner through the courtesy of Professor W. L. Puffer, of Boston, 16-c.p. incandescent lamps from eleven different makers. The lamps were obtained directly from the makers or their authorized agents, and were known to be for test.

These lamps were all sold for 16-c.p., 110-volt, no watts specified, and may be fairly assumed to represent the product which would be shipped to consumers who did not desire the lamps for test, although one batch of lamps came with the bases marked to show the point to be turned toward the photometer screen.

On test these lamps, thirty-three in all, averaged 14.1 mean normal c.p. and about 11.7 mean spherical c.p. Only one batch of three averaged over 16 normal c.p. One batch fell below 11 normal c.p. and two below 12 normal c.p. Five makers fell below 14.5 normal c.p. The highest average of any batch was 16.99, the lowest 10.82. The average consumption of energy was almost exactly 4 watts, the lowest 3.78 watts per candle, and two batches ran over 5 watts. It should be noted that the voltage was determined by a Weston voltmeter freshly compared with Clark cells, and each lamp was run at its marked voltage (110).

A separate series of tests showed that these lamps on the average gave their greatest mean c.p. when measured under rotation with their axes tilted 44 degs. and 24 minutes from the vertical toward the photometer, thus confirming closely your committee's estimate of 45 degs. as a proper angle. A series of tests on proper speed of rotation showed that the best results were obtained with a speed of 200 to 250-r.p.m, and that the lamps would readily stand this speed.

Many of the lamps showed bad spherical distribution, which seems to be quite needless, since it is merely a matter of proper proportioning the form of the filament.

Of an equal number of batches of 32-c.p. lamps, only one batch averaged 32 normal c.p., the majority falling to from 26 to 28 c.p. The 32-c.p. lamps averaged slightly greater efficiency, but were otherwise much like the 16-c.p. size.

From this investigation the fact stands out that the incandescent lamp sold for 16-c.p. is, on the whole, a lamp which is often giving considerably less than its rated c.p. even when new. Some of these lamps would probably show a temporary increase of c.p. after, say, fifty hours' burning, but the committee has not extended the research in this direction as yet, and adheres to the opinion that the initial c.p. is the only practicable commercial test, and any increase consequently is simply to be regarded as a device for keeping the lamp a little longer from its inevitable decay.

From these and other data kindly furnished by manufacturers and obtained from various other reliable sources your committee is convinced that the need of a uniform rating is even greater than is concluded in the preliminary report of last year, and that a rating test, in order to be effective, must involve measurement of c.p. of lamps in more than one direction. Neither mean horizontal, nor mean spherical c.p., nor c.p. in any one direction will define a lamp well enough to warrant adherence to the rating. Your committee therefore recommends that incandescent lamps be required to conform both to a standard mean normal c.p. and to a mean c.p. when involved with the axis tipped 45 degs., this representing the spherical distribution. It recommends that the limits for the mean normal c.p. be 15 and 17.5-c.p. Unless the minimum be as high as 15 there will certainly be found a tendency to produce lamps near the lower limit. The 45 degs. should be at least 85 per cent of this minimum. This is not an excessive requirement, and will tend to prevent working near the lower limit of horizontal c.p., unless with a lamp very good in other respects.

Your committee has blocked out a standard form of photometer, a type of which it proposes to build, test and put at the disposal of the association with directions for proper use.

It suggests that testing be by sample, a lot of ten lamps being taken from each barrel. Of these no lamp when run at its marked voltage shall show less than 15 or more than 17.5-c.p., mean horizontal, when rotated at 200 to 250-r.p.m.; and no lamp shall give when thus rotated at 45 degs. inclination less than 85 per cent of the above minimum.

NORTHWESTERN ELECTRICAL CONVENTION

The convention afloat of the Northwestern Electrical Association was a decided success, not only with respect to the object for which that body exists, but also as furnishing the members and guests a most agreeable excursion and an instructive tour of industrial inspection.

The excursion steamer "Northwest" sailed from Chicago early Friday afternoon, June 10, and in the evening a stop was made at Milwaukee for delegates. The next evening at 8 o'clock the boat arrived at Sault Ste. Marie, and a meeting immediately after was held at the Hotel Iroquois. A warm welcome was extended by the Mayor in an address, and an electrically illuminated arch in the street testified to the sentiments of the citizens. On Sunday a visit was made to the works of the Lake Superior Carbide Company, to the electric power plant of the Lake Superior Paper & Pulp Company, and the electrically operated lock of the great canal, built by the Canadian Government.

The steamer left Sault Ste. Marie at 2 P. M., and early the next morning arrived at Hancock. Taking a train, the delegates visited the wire mills of the Tamarack and Osceola mines and the smelting and stamping works of the Calumet & Hecla mines and the Superior power house, returning to the vessel in the afternoon and sailing at 4 P. M. for Duluth.

Early on Tuesday morning the ship arrived at Duluth, where Mayor Truelson delivered an address of welcome. In the evening a banquet was held at Superior, and at noon on Wednesday a train was taken for Minneapolis, where a dinner was given to the delegates, at the Mercantile Club, by Mr. Morgan Brooks, which was followed by a drive through the parks, ending at the railroad station, where a train was taken for Chicago.

About 100 delegates and guests were in attendance. Sessions aboard the "Northwest" were held on Saturday and Monday, and in the Duluth City Hall on Tuesday.

Mayor Truelson, of Duluth, in his address of welcome, spoke of the fact that at Sault Ste. Marie there are 200,000 h.p. waiting development, and suggested that this power should be harnessed to reduce the best iron ore in the world, which is found in inexhaustible quantities close at hand. As an instance of the great industrial development of that section, he said that the Calumet & Hecla mines and others in the near neighborhood paid out no less than $600,000 monthly in wages.

At the Hotel Iroquois, Sault Ste. Marie, Prof. Elisha Gray delivered an entertaining address, which was enlivened by a number of amusing reminiscences of the early days of electricity. In conclusion, he said that he did not know what the outcome of electricity is to be, but he is sure that we have not reached the end by any means. He thinks that some now living may see the time when the steam engine will be done away with, when the energy which is stored in wood and coal will be converted directly into electricity without passing through the state of heat.

One of the most interesting addresses of the excursion was an impromptu one delivered by Mr. Ischisuke Fujioka, of Tokio, Japan. After some courteous remarks on the pleasure which he had experienced on the trip, Mr. Fujioka took opportunity to say a few words about lightning, which was the topic of the morning's meeting. He said that barbed wire was run on the pole lines of the Tokio-Edison three-wire system, and there has not been a single instance of damage done, although Japan is very often visited by severe thunder storms. Thus far many of the so-called lightning arresters have failed to give good satisfaction in Japan, but he considers that an efficient form of this device should be installed upon long transmission lines.

During the passage Mr. F. E. Barker, Gas Commissioner of Massachusetts, was invited to address the convention, and chose as a subject the mutual relations of municipalities and electric light companies. The government, he said, whether State or municipal, is just as strongly bound to perform certain duty toward the companies as the companies are to render certain other duties to the municipality and the public. A company's ability to satisfactorily serve the public is generally proportional to the degree of prosperity it enjoys, and the kind of service which comes from an impoverished concern to whose embarrassment misdirected official effort may have contributed, is frequently well-nigh a public misfortune. He referred to the fact that some managers, unfortunately, are apt to narrowly and unwisely assume that because the public gives them certain advantages all are therefore theirs, and that they are under no obligation to share any of them with the public.

As to the growth of municipal plants in Massachusetts, he said that most of them have been built where private capital saw no inducement to go. There are two or three cases where this has not been true; in one the company induced the town to buy its plant; in another the company refused to accommodate the public and a municipal plant was a natural result; in still another the business seems to have been assumed as a matter of politics.

Following are abstracts of the papers read before the convention:

PURIFICATION OF WATER.

Mr. Dow read a paper on the purification of water, describing a method employed in his station. The station uses two vertical fire tube boilers, each containing about 1800 small tubes, and of 30-h.p. capacity each. In order to get pure water for these boilers, two tanks or cisterns were made of brick or Portland cement, 46 ft. in diameter, and 6 ft. deep. The cistern is filled with water from the hot well of the jet condenser used, and at the same time a small amount of whitewash is added. The exact amount is determined by adding a few drops of a weak solution of silver nitrate to a little of the water in a tumbler, when a red precipitate will be formed if a sufficient amount of lime has been added. After the water is settled in the tank for about half an hour, a solution of soda ash is added, and then if the water is at all muddy a very little alum is also added. Within an hour the water begins to turn a greenish blue, and within two or three hours it may be drawn from the top if necessary, though it is preferred to allow twelve or fifteen hours for settling. The function of the whitewash is to precipitate the soluable bicarbonate of lime in the form of a normal carbonate which is insoluble; soda ash is added to precipitate the sulphate of lime and the excess of whitewash. At first only whitewash was used, but when it was found that a tenacious scale was deposited soda ash was added, after which no scale was formed, and the very small amount of precipitate which finds its way to the boiler never cakes, but remains as a mud until blown off.

MECHANICAL DRAFT.

Mr. W. B. Snow read a paper on mechanical draft, in which he brought arguments to bear showing that the substitution of a fan for a chimney as a means of draft production is a distinct advance in the economy of steam generation. Not only does its application insure an economic gain, but in both its installation and operation there are certain conveniences which are to be considered as distinct advantages, although it may be almost impossible to determine their definite economic values. Mr. Snow considers that under certain conditions a combination of force and induced draft may be found desirable.

Among the advantages of mechanical draft is that it is both positive and flexible. The fan is always at its best, can be instantaneously pushed to its utmost, and does not have to wait for a hotter fire to produce a stronger draft. When properly installed, a fan should be provided with an engine devoted solely to its driving, and the speed of this can be so controlled as to increase in proportion as the steam pressure falls, thus making it possible under all ordinary conditions to maintain a practically constant steam pressure and to insure immediate response to sudden demands. The fan lends itself admirably for use in connection with heat economizers, and another feature of convenience is to be found in the ability to burn cheap fuels and in abating the smoke nuisance.

Mr. Snow stated that tests of nine large boiler plants equipped with economizers and mechanical draft are reported by Roney to have shown on an average a saving of about 14 per cent. As to forcing, he points out that low combustion and evaporation rates are not essential to high efficiency.

INCANDESCENT LAMPS FOR INCLOSED ARC RESISTANCES.

In answer to a query deposited in the question box as to the practicability of substituting an incandescent lamp in place of wire resistance in direct current inclosed arc lamps, Mr. J. W. Mabbs gave the result of some experiments on this point which he had made. He found that an inclosed arc works much better with lamps substituted for metal resistance, and the light from such lamps can be utilized. He uses six lamps of 10 c.p. in multiple series, each one consuming about 1 amp., from which very good results are obtained. The lamps used are of about 4 watts per c.p., so that if one lamp breaks the other five will carry the current until the broken lamp is renewed. Eight or ten arc lamps have thus been fitted, the glow lamps being placed from 50 to 60 ft. distant. Mr. Kimball stated that in Hartford, Conn., extended experiments have been made in this line and a special form of series lamp adopted, which is installed in stairways, entries and places of that description. The experiment had been very successful, and about fifty arc lamps have been thus fitted.

ELECTRIC SMELTING.

In the absence of Mr. W. S. Horry, Mr. Doherty read a paper contributed by that gentleman on electric smelting. The paper referred to the fact that in the manufacture of carbide of calcium there are molten masses weighing a ton or more at the temperature of probably 3000 degs. C. in immediate proximity to cast iron surfaces that would be melted if a temperature of 1100 degs. C. was reached. The enormous temperatures of electric smelting are, nevertheless, easily under control, and the heat can be indicated very accurately by means of a wattmeter, so that results once obtained in this apparatus can always be duplicated with ease. He spoke of some experiments with sulphide nickel ore found at certain mines in Ontario, from which it was proposed to extract the sulphur to be used as sulphuric acid in paper making. Roasting the ore in a regenerating furnace did not produce the proper results, but when it was ground up and mixed with lime and carbon and subjected to heat in an electric furnace the sulphur was entirely eliminated and the nickel was separated from the iron, thus demonstrating that nickel in the free state of purity can be obtained by this process. In another instance pure copper was separated from a matte of copper, nickel and iron when smelted electrically. The carbide furnace used at Sault Ste. Marie consists of cast iron drums 10 ft. in diameter and 2 ft. long, mounted on a shaft and slowly rotated by a hand worm gear; the electrodes are carbons 2 ft. long and 4 ins. square; there are four pencils in an electrode, and the two electrodes are separated by a space of 8 in., the axis being the axis of the furnaces. As the ore is reduced the resultant metal lowers the resistance of the furnace, when the latter is slowly rotated, by which movement the metal is drawn away from the electrodes and fresh ore is brought between them to be acted upon. The voltage is 100, and about 1500 amps. of current are used.

LIGHTNING ARRESTERS.

Mr. A. J. Wurts delivered an address on the subject of lightning arresters, in which he stated that not long ago the president of a large electric plant wrote to him asking whether he thought it possible to absolutely protect a plant against lightning; he answered that he thought that it could be absolutely protected against all ordinary effects of lightning, although there are, of course, exceptions. Mr. Wurts stated that the deductions obtained from experimenting with a static machine may be applied to lightning discharges, the phenomena observed in the first case corresponding with those accompanying the latter.

Referring to statements made that a lightning arrester should have a low breakdown e.m.f., he said that a lightning arrester has nothing to do with the e.m.f. of a dynamo. The only standard for the resistance of a lightning arrester is the ease with which it will conduct oscillatory discharges to earth, and this has absolutely no reference to ohmic resistance or breakdown e.m.f. He said that what he calls a free path for an oscillatory discharge is one which has a spark gap or several spark gaps; the discharge will smash the air between the gaps and thus form at once a free path for the electrical oscillations.

Referring to the underwriters' requirements that lightning arresters must be connected with a thoroughly good ground connection by metallic strips, the wires having a conductivity of not less than that of No. 6 B. & S. wire, and must be run as nearly in a straight line as possible to the earth connection, Mr. Wurts asked why such a rule as this should be made if there is put in the circuit of the lightning arrester an ohmic resistance many times that of the ground connection?

The question having been asked whether on an overhead three-wire tension distribution additional protection is afforded against lightning by grounding the neutral wire at various points throughout the system, Mr. Wurts replied that in his opinion the grounding of the neutral wire might and probably would protect the generator, but he did not think that the ground would protect apparatus at any considerable distance from the point at which the wire is grounded. He said that the self-inductance of a perfectly straight wire is so great on oscillatory discharges that the discharge will not travel any considerable distance, but will jump to the ground in preference. If the neutral is grounded as it enters a house, it will very materially protect the apparatus in that house. If grounded at frequent intervals, apparatus in the neighborhood of the grounds will be protected. Should the grounding of the neutral assure safety from oscillatory discharges, this would only apply to that wire, but would not relieve the other two wires of the necessity for lightning arresters.

In reply to a question, Mr. Wurts stated that an overhead ground wire is not a good protection from lightning. It may help to protect under certain circumstances, but lightning arresters should not be dispensed with. He thinks that barbed wire, however, has advantages over plain wire, for the reason that points drain electrical discharges much more rapidly than smooth surfaces.

INCANDESCENT LAMPS.

Mr. S. Everett Doane in a paper on the subject of incandescent lamps, called attention to the fact that the old theory which ascribes the blackening of lamps to the evaporation of carbon and a subsequent condensation on the bulb, has been replaced by one which refers the blackening to a chemical effect. He dwelt upon the fact that an incandescent lamp has no particular c.p., being capable of delivering as many definite c.p. as definite voltages are applied. Change of resistance has very little to do with the change of the c.p. of a lamp, for a well constructed incandescent lamp does not change its resistance materially throughout its effective life; the c.p., however, changes considerably, due to a change in the radiating power of the surface of the filament.

Mr. Doane laid down two principles concerning the c.p. of incandescent lamps. First, that the c.p. never remains absolutely constant, but falls continuously, barring the first sharp rise; and, second, that the curve of change in candles is nearly a straight line, and for all practical purposes can be considered as such, neglecting, of course, the rapid rise at the commencement of the life and the sudden slump at the finish. As to the initial rise in c.p., this is usually very rapid, the maximum incandescence being frequently reached after the first one or two hours. Stress was laid upon the point that a purchaser should have a care that he does not test a lamp until after it has burned some time, in order that the peak in the curve shall not be encountered. He does not believe in the method of putting a planimeter on the curve, and averaging the c.p. hours up to the time when it has fallen a given percentage, 80, for instance, as this, he considers, places a premium upon the initial rise in c.p.

The statement was made that incandescent lamps lend themselves quite easily to deception. For example, a little rough handling of the lamp on the pump will blacken the filament, which will increase the c.p. for a period of a couple of hours until the sooty coating has been burned off. Mr. Doane believes it is very difficult for even a lamp expert to see any difference between a 20-c.p. and a 16-c.p. lamp, if both lamps are operating at the same watts per candle.

In summing up, Mr. Doane stated that lamps rise in c.p.; that everything is being done to obviate this and that eventually it will be entirely avoided. Bright lamps and dim lamps are equally objectionable and the most important consideration in determining from a life test the best available lamps for central station use, is that the true initial c.p. of the lamp under test be properly determined.

In the discussion of Mr. Snow's paper Mr. Doherty stated that in a test which he made of a steam pump he found that it used steam at the rate of 150 lbs. per h.p.-hour, and he figured out that in that particular case by pumping electrically this consumption would be reduced to about 26 lbs. per hour. Mr. Doherty considers that mechanical draft must be forced in order to do efficient service. In his station a Hazen boiler is used, a portion of which is cut out, when necessary, and thus a good efficiency maintained—this being 59 per cent with a very bad load. He said that one time he attempted to build a smokeless furnace but obtained a lower efficiency than with a smoky furnace, this fact being due to too great an admixture of air.

Mr. Dow said that he found that better results could be obtained with a thick layer of fuel than with a thin one, and he considers that the ordinary idea that a very thin bed should be used is entirely wrong.

Mr. Cross belives that small stations do not need mechanical draft, economizers or automatic stokers, and he does not think they are worth considering in plants in cities of less than 50,000 inhabitants.

COST OF ELECTRIC POWER.

RENTED POWER FOR ELECTRIC RAILWAYS.

For the purpose of determining just what price was being paid for electric power by the street railway companies throughout the country which do not operate their own plant, but rent or purchase power from outside companies, letters were addressed to all the companies in the United States that were known to purchase power. The replies received are given below and form a very interesting study. Most of the information received was given in confidence, and it is therefore impossible to publish the names of all the companies reporting. The replies received are as follows:

A company operating twenty-four motor cars and nine trail cars on 18 miles of track pays $.011 per k.w. hour.

A company operating five cars on 6 miles of track rents power from an electric light company at $1.80 per car per day of eighteen hours, the street railway company owning the generator and the electric light company paying all expenses of running it. The street railway company states, however, that it has recently been notified that this rate will be raised to $2.10 per car per day, as the present figures do not cover the entire cost.

A company operating four motor cars daily, and on extra occasions six motor cars and occasionally trailers, and owning 6 miles of track, pays $2 per day for each of the four motor cars, and $1.50 per day for each additional motor car and 50 cents per day for each trailer in excess of twelve days in each month. This street railway company states that its contract for power has been in force four years with satisfaction to both parties, and thinks this arrangement cheaper than owning and operating its own plant for so few cars.

A company operating about five cars pays a fixed charge of $12.50 for five cars or less per day, and $2 for each additional car above that number.

A company operating ten motor cars on 6½ miles of track purchases its power from a lighting company on a car-mile basis, paying $.015 per car mile.

A company operating in the South reports as follows: "We rent our power from the city on contract for five years, the rate being $.015 per k.w. We, however, put up the feeders for a distance of 3¼ miles, using the city's poles to string them on. Our meter is at the power house end, and the expense to operate eleven cars, eighteen hours per day, runs from $660 to $680 per month. We have a great many steep grades and our main line is up grade for over 2 miles. We operate eight cars per hour over this grade, and on another line we operate four cars per hour over a grade of 1½ miles in length; on still another line we have a very steep grade, but only about 1500 ft. long; over this line the cars make a round trip in fifty-one minutes, there usually being three cars on the line. We have a number of slight grades on other parts of our line, and taking everything into consideration, we have quite a hard street railway city, but we consider our rate reasonable."

A company operating fourteen motor cars and two trail cars on 7½ miles of track purchases power from an electric light company, paying $3 per car per day. The electric light company is owned by the same interests that control the street railway company.

A company reports as follows: "Our company owns its own generators and a gas company furnishes us with steam power, together with the necessary labor to operate the generators. For two of the generators our company pays $19 per day of nineteen hours; for three others $7 each per day, and for four others, which is the extent of our contract, $6 each per day. Our power bill last year, based on the number of car miles, was $.02125 per car mile, this amount including heat and light for the cars, also light for the stations. No extra charge is made for snow plow service."

A company operating sixty motor cars and twelve trail cars on 20½ miles of track buys power for less than $.03 per k.w. hour.

A company operating four cars about seventeen hours per day and owning 3½ miles of track has a contract with an electric light company by which it pays $50 per month for power. The average ampere load at 500 volts is about sixty.

A company operating fourteen motor cars on 8 miles of track reports that it pays on one of its lines $3 per car per day, which includes maintenance of lines; and on the other branches $2.50 per car per day, which does not include cost of maintenance.

A company reports that it furnishes power to a number of street railway companies, a uniform charge of $.03 per car mile being made to all.

A company pays $10 a day for power for three cars from 6 A. M. to 11 P. M. These cars run about 425 miles in that time. For extra cars it pays $1.50 per half day, or if only one trip is made, $.25 an hour.

A company operating seven motor cars on 7 miles of track reports that it rents power from an electric lighting company and pays $2.75 per day of eighteen hours for each car operated.

A company operating 10½ miles of track places its own dynamos in the power station of an electric light company, the electric light company furnishing the power and attendance and caring for the machines. For this the street railway company pays at the rate of $2 per day of eighteen hours for each of five motor cars, with the additional right of attaching two trailers without cost. For all additional motor cars a charge of $1.85 each per day is made, and for additional trailer cars $1 per day. This amount also includes light for the cars.

A company owning 4½ miles of track pays $200 per month for its power and operates daily five cars and on some occasions as many as nine cars. The company states, however, that the power is rented from a company very closely connected, and that the cost for power is considerably less than it could be purchased from outside parties.

A company owning 3 miles of track pays for its power $6.50 for two cars per day; some parts of the year one S. R. F. 30 motor and one G. E. 800 motor are run, and at other times two S. R. F. 30 motors.

A company owning 7.5 miles of track has a contract with another company for all its power used. This contract calls for a minimum payment of $12 per day for a maximum number of four cars, operating sixteen hours. Eight bench open cars and 16-ft. closed cars are used, each car being equipped with two Thomson-Houston S. R. G. 30 motors, with old-style controller and rheostat.

A company operating several large lines reports that the approximate charge for power is about $2.50 per car per day for a certain number of cars, and this amount less 10 per cent for additional cars. A trailer is allowed to one or two motor cars under certain conditions.

A company operating three motor cars on 1½ miles of track reports that up to a short time ago it paid from $4 to $4.50 per car per day for power.

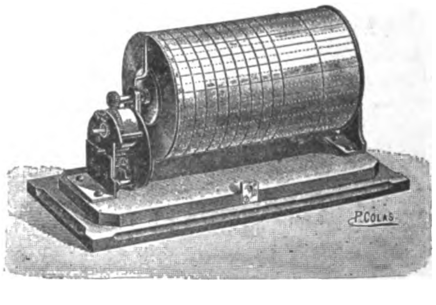
A company owning 4 miles of track pays an electric light company $6 per day of fifteen hours for power for two cars with double 30 h.p. motors each.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

An Electric Water Glass.—According to "L'Elettricità," a hydrographic engineer of Cracow, M. Malachowski, has desigened a simple and satisfactory apparatus for viewing bodies submerged to a depth of 40 to 60 feet. It is composed of a binocular telescope to which is attached a long zinc tube which plunges under the water. On the bottom of this tube is arranged a cylindrical chamber containing a system of mirrors and incandescent lamps, the aperture of the tube being closed with a glass window. Weights attached to the lower end of the tube balance the apparatus in the water.

Automatic Station Log Book.—In stations where the readings of the switchboard instruments, etc., are recorded in a log-book at regular intervals the tendency of most employees is to invent figures whenever they are prevented by any cause from making the entries at the proper moments, and thus to produce a record which is useless and misleading. To secure the registration of the figures at the proper moments and to guard against the filling out of the sheets with arbitrary numbers at the leisure of the man in charge, M. A. Peyramale, engineer of a lighting station at Bordeaux, has devised a simple piece of apparatus which is illustrated in "L'Industrie Electrique." The sheet for the daily log, properly ruled, is mounted on the face of a cylinder which is turned by clockwork. The illustration shows the cylinder with the sheet in place. Covering the cylinder and clockwork is a case with a narrow slot in the top through which the figures may be written in their proper places. The cover is locked in place so that the apparatus may not be tampered with, and the whole forms a neat and convenient method of handling the log sheets. The further advantage of clean sheets is also secured by its use, as the switchboard man only touches the sheet with his pencil or pen.



AUTOMATIC STATION LOG BOOK.

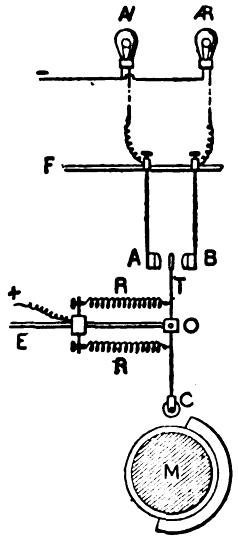
X-Ray Photographs of Alloys.—The X-rays have been applied by Messrs. Haycock and Neville to the study of the structure of metallic alloys, their paper on the subject having been presented to the Cambridge Philosophical Society. When the alloy is composed of two metals of different transparencies radiographs of thin plates show the separation of the two during solidification. Thus an alloy of aluminum and gold shows on solidification a precipitate of the compound $AuAl_2$, which separates out in octahedral crystals.

The Motorwoman.—Our rather sprightly contemporary, "L'Energie Electrique," commenting on the sport of "automobilizing" as practiced in France, says: "The Duchess d'Uzès by applying for a license as driver of an automobile has not made the sport aristocratic, for that social formality was long ago performed, but she has feminized and consecrated it. This noble example, we feel sure, is going to be followed by troops of duchesses, princesses, marquises and other belles dames fleurdelysées.....The leaders of commerce and finance will not fail to automobilize themselves in their turn, and the time will soon be here when the valet will say to us without causing astonishment: 'Madame has gone out to try her new motor in the park.'"

A Simple Electrolytic Meter.—A novel and simple electric meter, the invention of Mr. C. O. Bastian, is described in the (English) "Electrical Review." It consists of a vertical cylindrical glass vessel of approximately uniform bore, containing at the bottom two platinum foil electrodes. The cylinder is filled with dilute sulphuric acid on which a film of oil is floated to prevent evaporation. The whole is enclosed in a cast iron case, having a scale graduated in Board of Trade units (k.w. hours). The graduation is effected directly for each instrument to avoid errors due to the varying bore of the tube. The fluid is electrolyzed by the passage of the current, the gases escaping and its level falling. When it is exhausted it is filled with water, and is then ready for another period of service. The meter is said to work very well, and its simplicity, cheapness and direct reading qualities seem to commend it as an excellent instrument where great accuracy is not necessary.

Temperature of Incandescent Lamps.—In a paper presented to the Académie des Sciences M. P. Janet gives the results of researches upon the temperature of incandescent filaments. The method used consisted of measuring the resistance of the lamp as a function of the e.m.f. across its terminals, and the variation with time of the resistance of the lamp while cooling. From these data the curve of watts radiated in any time and the heat units given off by the lamp may be deduced. Then by weighing the filament the temperature can be deduced from Violle's formula. The experiments were made on four lamps of 10 c.p. at 65 volts. The results showed temperatures of 1720, 1610, 1630 and 1620 degs. (Centigrade) for the various lamps, which are remarkably accordant. The principal difficulty with the method outlined is that of accurately weighing the very light filament, but the author suggests that to avoid this low voltage lamps with thick filaments can be employed for future work.

A Simple Speed Indicator.—Among the auxiliary apparatus on naval and other vessels are helm indicators and revolution counters. The simple apparatus described here, due to M. Cadiou and illustrated in "L'Electricien," is of the latter class, and is so designed that it may be made out of material on hand and applied to almost any steam vessel having an electric light plant aboard. A glance at the illustration renders a description almost unnecessary.



SPEED AND DIRECTION INDICATOR.

The main shaft is shown at M and carries an arc which engages with the roller C. This is at the end of a rod which is held by the opposing springs RR, and carries at its other end the contact point T. The lamps shown are connected with the points A and B, so that one of them flashes for each revolution of the shaft in one direction while the other flashes if the motion is reversed. To time the revolutions all that is needed is a watch. The lamps may, of course, be put anywhere about the vessel that is most convenient.

Rare Oxides in Incandescent Filaments.—"L'Eclairage Electrique" gives a short discussion of the recent researches and theory of M. Bunte concerning the effect of the rare oxides used in incandescent gas burner mantles when used in electric lamp filaments. It appears that the office of the oxides is two fold. The oxide of cerium, which is always present in the mantles in larger or smaller quantities, is to cause, by its catalytic action, a more violent combination of the elements of the gas and the air, and thus to make the mantle the seat of very energetic action. The oxide of thorium, which constitutes the greater part of the mantle, has, according to M. Bunte, no special emissive power, but, on account of the energetic action just described and its own lack of conductivity, is raised to a very high temperature. In support of this theory, it is stated that mantles of pure ceria or thoria do not give more than one-tenth to one-twentieth of the light radiated by one composed of these materials mixed together. Carbon, magnesia, ceria and thoria heated to the same temperature in an electric furnace gave the same emission of light. On these accounts, it is held that the addition of these oxides to the carbon filament in an incandescent lamp will have no effect upon the light emitted by it.

Air Circulation in Telephone Cables.—A very interesting paper on dry air circulation in telephone cables was read by M. A. Barbarat before the Société Internationale des Electriciens, and has been translated by the "Electrician." It appears that when enlargement of the Paris telephone system required the substitution of cheaper and smaller cables than those which had been installed originally an experiment was made with dry paper cables having the ends paraffined to keep out moisture. These cables were successful, but were liable to be injured by the absorption of moisture through any break in the lead covering, especially as the most of them are laid in sewers. To obviate this trouble dry air is kept circulating through the cables. The cable heads are of wood, and, as it is impossible to make these tight enough to resist the air pressure used, the end of the cable is sealed with paraffin and the air led in through a pipe tapped into the cable behind the seal. The air is dried by passing it through six cylinders 1 ft. in diameter and 6 ft. long containing calcium chloride. In cables in sewers or elsewhere where they are liable to be covered with water the pressure is kept at 45 lbs. A puncture is immediately shown by a meter on the air supply pipe. The results obtained from this system are said to be excellent.

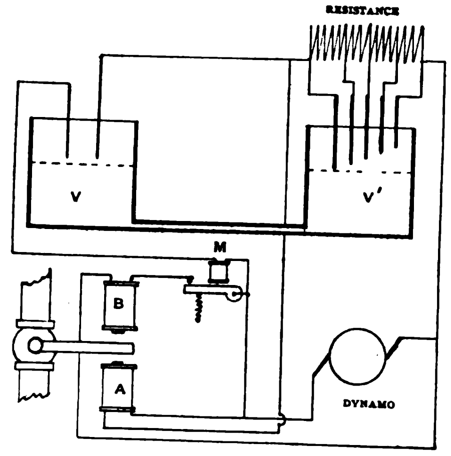
Effects of Electricity Upon Germination.—Sig. Tolomei has presented to the Accademia Reale Lincei a note upon the effect of electricity upon the germination of seeds, which is abstracted in "L'Elettricità." It had been previously noted by the author that seeds under the action of the electric current augment in weight more rapidly than those under normal conditions. His present experiments tend to show a diminution of the period of germination under the same action. An apparatus was used which traced a curve upon a cylinder making one revolution per week, two simultaneous curves showing the swelling of two seeds in water, one of them being subjected to the influence of electricity. The research was carried on with seed in water charged negatively and positively, and also permeated by alternating and continuous currents. In the first case, where the water was negatively charged, there was a diminution of the time of absorption when the sky is clear, that is, when the charge of the atmosphere is positive. When the charge of the seed is positive the reverse takes place. Both alternating and direct currents were shown to shorten the time needed for the seed to reach the state of saturation, but the total amount of water absorbed is the same as in the normal case. The author hints that seeds which require a very long time for absorption ordinarily may have their germination hastened by the electric current or even by simple electrification.

Electrolytic Manufacture of Iodoform.—A process for the electrolytic manufacture of iodoform has been devised by K. Elbs and A. Hertz and described in the "Zeitschrift für Elektrochemie." Iodoform is produced by the reaction of iodine upon warm alcohol in the presence of an alkali or an alkaline carbonate, the formula being:

$$CH^3CH^2OH + 10\,I + H^2O =$$
$$CHI^3 + CO^2 + 7HI.$$

This reaction can be brought about by passing a current of electricity through a solution of iodide of potassium and caustic soda containing alcohol. Under the action of the current potassium and iodine are set free. The hydriodic acid or the iodides formed by secondary reaction are immediately redecomposed, so that the iodine not used up in the production of iodoform is almost entirely regenerated, only a little appearing at the anode as iodate. The best results are obtained when the temperature of the bath is between 60° and 70° Centigrade. Too much alkali diminishes the output of iodoform and favors the formation of iodates. The current density should not exceed 10 amps. per square foot. Good results are obtained with an electrolyte containing 16 to 17 per cent of alcohol, 4 to 5 per cent of sodium carbonate, and 8 to 9 per cent of potassium iodide. Iodic acid forms very slowly and does not interfere with the main reaction for some time. The efficiency of the process is stated to be as high as 97 per cent of the theoretical possibility, which is 1.468 grammes of iodoform per ampere hour. The iodoform produced is crystalline and very lightly tinted with yellow.

Electric Regulator for Marine Engines.—In a heavy sea when a vessel is pitching the screw is often thrown up into broken water, or even clear of the water altogether, thus suddenly throwing the load off the engine and starting it to race. When the screw descends with the backward pitch a severe shock is given to shaft and engines. A recent device for the electrical control of engines under these circumstances is described by Sig. E. Putato in "L'Elettricista." It consists of two vessels of mercury, V and V¹, connected by a tube, and mounted fore and aft in the ship, V¹ being towards the bow. The normal level of the mercury is indicated by the dotted line. When the vessel pitches forward so as to raise the screw the rods connected with the resistance are submerged one after the other, so that the electro-magnet, a, is brought into play, the whole resistance being short-circuited when the screw is lifted clear of the water. The electro-magnet operates a throttling valve in the main steam pipe, which is thrown open by another magnet, b. This is worked through a contact controlled by an auxiliary magnet, m, which is in turn thrown into circuit by the immersion of the contacts in vessel V. By this arrangement the steam is turned on full head as soon as the screw is immersed by the backward pitch. In still water neither set of contacts is immersed in the mercury and no current is consumed. From experiments, which are said to have been very satisfactory, it is stated that the mercury vessels need not be more than 34 inches apart on a 300-foot ship.



ELECTRIC REGULATOR FOR MARINE ENGINES.

Electrodes for Electrolizing Alkaline Chlorides.—In an article in "L'Industrie Electrochemique," M. H. Becker notes the various sorts of electrodes used in the electrolysis of alkaline chlorides and reviews their advantages and defects. Carbon in some form is the material most commonly employed, the electrodes being made of the ground carbon mixed with some binding material rich in carbon and heated under pressure in a closed mould. The resistance of such electrodes to the destructive action of the evolved chlorine and oxygen is greater as they are more compact and less porous, so that the least possible quantity of the binding material should be used and the calcination carried on at high heats. A process has been developed by Messrs. Girard and Street in which the high temperatures of the electric furnaces are used. Certain metallic oxides are also frequently employed, among them peroxide of lead, iron plates covered with a layer of magnetite (Fe_3O_4), or better, plates covered with a layer of ilmenite, an oxide of iron and titanium, having the formula $FeTiO_3$. Among metallic electrodes the most useful are those of platinum-iridium, containing about 10 per cent of iridium, which are used in several chlorate of potash works. Pure platinum electrodes are not so good and those of platinized metal are worse. These electrodes are generally made of wire gauze or thin sheets of the metal stretched across frames. Both ferro-silicon and the phosphide of chromium have been suggested as proper materials for such electrodes. For cathodes carbon, iron or nickel are generally used. Mercury is employed in the Castner and Kellner process, and black oxide of copper in some others.

Carbonization of Filaments by Electric Heat.—There is nothing new in the idea of applying electric heat to the carbonization of incandescent lamp filaments, but for some reason this method seems to have been neglected. Mr. Legh Powell writes at some length in the (English) "Electrical Review" describing some experiments made by him to determine if this method was feasible. He used a brick trough, containing carbon blocks on which the filaments were wound, packed full of powdered carbon. At the bottom of the trough was a layer of plumbago powder sprinkled with paraffine, which by its volatilization displaced the air in the apparatus. The filaments obtained were in every way satisfactory, being of good color and flexibility and uniform resistance. The current required to heat a row of blocks about 10 ft. long started at 18 amps., was increased slowly to 25 amps., was 30 amps. ten hours after the start, 35 amps. in 12 hours and 65 amps. in seventeen hours. At this point current was turned off for six and one-half hours and then started again at 27 amps., increasing to 65 amps. in six hours, at which time it was finally shut off. The advantages which the author foresees for the electric method of cooking filaments are the more perfect control obtainable, which must result in a more uniform product, and the saving of labor in working the process. He thinks that the initial cost of the apparatus would be less for electric heating, while the compactness of the apparatus makes possible heating the filaments in vacuo or under other unusual conditions, and the uniform high temperatures that may be attained might result in filaments of a very hard and dense character.

Reduction of Silicon in the Electric Furnace.—Some time ago M. Moissan showed that silica is reduced by carbon at the high temperature of the electric furnace. In recent researches by M. Lebau for the preparation of glucina by the electric furnace, described in "L'Eclairage Electrique," it has been discovered that it is possible to prepare silicon on an industrial scale from rough emerald. A charge of 220 pounds of powdered emerald and 110 pounds of coke was heated for an hour by means of a current of 1500 amps. The inner layer of the furnace product showed a crystalline fracture and almost the color and appearance of crystallized silicon. Analysis showed that the mass contained about 64 per cent of silicon. Treating the mass with hydrofluoric acid and then with sulphuric acid left a residue consisting of silicon containing about 1 per cent of silicon carbide. Some samples showed as much as 80 per cent of crystals of silicon.

It is interesting to note in this connection that silicon has certain properties which are claimed to make it of great value as a high resistance material for use in electric heating apparatus of all sorts.

Cement for Leather Belting.—A cement recommended by the "Mechanical World" is made by kneading 10 parts of carbon bisulphide and 1 part of spirits of turpentine with gutta-percha until the result is a thick paste. The portions of the leather where the cement is to be applied are to be unrolled and roughened, and the joint kept under pressure until the cement is dry. Good rubber cements for rubber goods or rubber on metal are obtainable by dissolving shellac in ten times its weight of ammonia water. After standing three or four weeks a transparent putty remains which is used cold. The cemented places soften at first, but harden after the evaporation of the ammonia, which may be hastened by heating. This cement is water-tight and gas-proof, and is efficient for hard rubber articles, a mixture of gutta-percha and asphalt also being serviceable for this class of work.

A New Standard of Light.—As the introduction into practical use of various high temperature sources of illumination increases, the difficulty attending the use of the older standards for photometric work also increases, as nearly all of these are of a reddish color. Various ingenious methods have been devised for overcoming the difficulty due to the difference in color between the standard and the light measured. The best method, however, is the use of a standard whose temperature and hence its color approaches that of the light to be measured. Outside of these considerations the conditions necessary for a standard of light are simplicity and definiteness of structure, permitting its easy and accurate reproduction, and some arrangement permitting the accurate measurement of the combustible burned. To meet these conditions M. Ch. Féry has lately suggested in a paper presented to the Académie des Sciences the use of acetylene burning in free air at the end of a thermometer tube cut off square. The inner diameter of the tube used in his experiments was about 1-50 in., and he states that differences of pressure of as much as 10 per cent make very little difference in the intensity of the light. The burner should not be forced to a greater consumption than about ¼ cu. ft. of the gas per hour. Under so small a consumption the difficulty of accurately measuring the amount of acetylene burned would be considerable, but it is an easy matter to accurately measure the height of the flame, a simple linear relation existing between this and the luminous intensity. M. Féry uses a camera giving an image of the flame in actual size on a strip of ground glass ruled in millimeters for this measurement. Between heights of 10 and 25 millimeters the proportion between the height of the flame and its illuminating power is almost exactly constant. Determinations of the exact value of the standard have not yet been made, but it is suggested that a use for it outside of its importance as a photometric standard is that it furnishes a ready means of comparing various kinds of carbides for the richness and illuminating power of the gases they generate.

Discriminating Cut-Out for Alternators.—When a number of alternators are working in parallel supplying the same bus-bars it is desirable to connect in the circuit of each some apparatus that will cut it out if it is motored. The use of any magnetic device to accomplish this end seems difficult when it is considered that the direction of the current is reversing several thousand times a minute, but in the cut-out described by Mr. Leonard Andrews in the (English) "Electrical Engineer" this difficulty is very neatly overcome. The apparatus is diagrammatically shown in Fig. 1. D_1 is the dynamo in whose circuit it is connected. It consists practically of a shunt motor, the stationary part of which is energized by a few turns of heavy conductor carrying the whole current of the dynamo. The moving part, SH, is wound with a fine wire coil connected through a small transformer across the bus-bars, the tendency of rotation under normal conditions being such that the switch shown at the right of the illustration is locked fast. If the current through the dynamo D_1 reverses with reference to the currents in the other parts of the system, that is, if the machine is motored, the movable part of the motor turns in a counter-clockwise direction, releasing the weight attached to the switch and opening the latter. Fig. 2 shows the apparatus as applied on the switchboard of the station at Hastings. It is said to be very reliable, and not apt to cause trouble by opening at the wrong time.

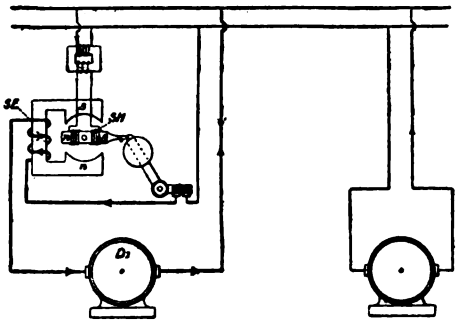


FIG. 1.—DISCRIMINATING CUT-OUT FOR ALTERNATORS.

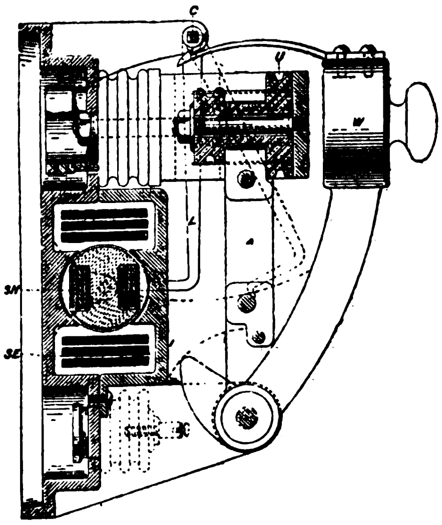
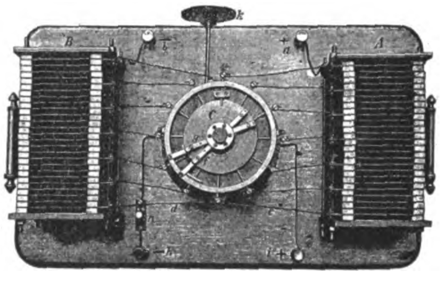


FIG. 2.—DISCRIMINATING CUT-OUT FOR ALTERNATORS.

Ammonia-Chloride Accumulators.—Under this title Senor A. Sandaran contributes to "Revista de Obras Publicas" (Madrid) a very long and complete description and data of a remarkable accumulator of his invention. It consists of a solution of sal-ammoniac which is electrolyzed between two electrodes of carbon, a porous diaphragm separating the liquid into two portions. In the fluid surrounding the anode chlorine is liberated and, according to Senor Sandaran, under the action of diffused daylight and sometimes even in the dark, this nascent chlorine decomposes the water of the electrolyte, forming hydrochloric acid, which is immediately dissolved, and oxygen, which escapes. At the cathode ammonia is formed, the unstable radical ammonium, NH^4, being generated by the electrolysis and breaking up into ordinary ammonia, NH^3, and hydrogen, which escapes, the water dissolving the ammonia. On account of the great solubility of the two gases, hydrochloric acid and ammonia, the capacity of a given volume of water for storing them in the dissolved state is very high, and suggests great possibilities in the way of capacity per pound of cell. In the experimental cell, of which a description is given, the charge was at the rate of 0.25 amp., and in another experiment at 1 amp., corresponding respectively to 2.5 and 10 amps. per square foot of plates. The cell was an ordinary battery jar using an ordinary porous cup as the separating diaphragm and two carbon plates in the outer jar and one in the inner jar as electrodes. There was no difficulty about charging at the higher rate. The fluid around the positive electrode became rapidly yellow from the formation of chloric and hypochloric acids. Experiments were also made upon the same cell with the spaces surrounding the electrodes filled with granular carbon. With this its internal resistance was found to be 0.07 ohm and without it 1.25 ohms. In charging the e.m.f is stated to be 1.67 volts at one-twentieth charge, 2 volts at half-charge and 2.2 volts at full charge. In discharge the current is said to be very constant and there is no disengagement of gas. The author states that after twelve hours on open circuit the loss due to admixture of the fluids was small, and that after from 40 to 80 days it was not greater than that in accumulators of the ordinary lead type. A table of comparisons is given showing data of 4 types of lead accumulators in comparison with an ammonia chloride cell. From this the following figures are taken: Capacity of the ammonia cell, 1257 ampere hours; useful capacity, 2388 watt hours; efficiency (in watts), 0.85; weight of plates, 17.6 lbs.; weight of complete cell, 22 lbs.; useful watt hours per pound of cell, 59; weight of cell for a capacity of one h.p. hour, 13 lbs. (an error in the table gives the latter figure at 11 lbs.). If these data are correct it is evident that this cell is by long odds the most powerful for its weight yet produced, but there seems to be reasonable ground to doubt the correctness of such remarkable figures. The presence of the porous diaphragm means either high internal resistance, which is fatal to both efficiency and high discharge rate, or else quick osmose of the liquids and consequent loss of charge. But the principal difficulty with the theory of the cell is that the nascent chlorine will not form hydrochloric acid with the water of the electrolyte if the charge rate is carried to a high point. Still, as the chlorine itself may dissolve in the water and subsequently combine with the ammonia this seems not to be a fatal objection, except that it destroys the author's very elaborate theory of the action of the cell.

For use as balancing cells, where the charge and discharge rates are sometimes excessive and where the capacity for storage for any great length of time is of no account, Senor Sandaran recommends a gravity type, similar to a bluestone battery, having a carbon plate at the bottom and another near the top, the intervening space being filled nearly full of granular carbon. The acid solution being heavier than the other the positive electrode should be the lower one. It is greatly to be hoped that the data stated are correct, but it is to be confessed that they will require abundant confirmation before they meet with general acceptance.

A Laboratory Direct Current Transformer.—Professor Julius Thomsen has presented to the Kgl. Danske Videnskabernes Selskabs an account of an ingenious direct current transformer for laboratory use, whereby a direct current of 110 volts is transformed to one of 7.2 volts, the current strength being correspondingly increased. The figure shows the apparatus in plan. A and B are storage batteries, each containing twenty-four elements of very simple and ingenious construction. The plates are of thin sheet lead about 4 by 5 ins. in size, every fourth plate being provided with an ear for the attachment of a connector. The twenty-four-cell battery is made by laying up the sheets of lead in a frame, a U-shaped piece of soft rubber having a rectangular section ⅜ by ⅝ in. separating every pair of plates. The end plates are held between two iron plates ⅛ in. thick, which are clamped together by bolts as shown in the illustration. A solution of 1 part sulphuric acid and 4 parts of water is used, and the plates are "formed" by a current of about 1 amp. Each of the lead plates plays a double rôle, as one side of it is coated with peroxide by the forming process and the other side reduced to spongy lead, while the central part of the plate forms the connection between the two. As the illustration shows, each fourth plate is connected in regular order to one bar of a commutator, C. Upon this work two brushes carried by the arms f and g, these being in contact with copper rings connected to the posts h and i. The arms f and g are so set that the brushes are always 30 degs. apart, so that one group of four cells is always connected to the posts h and i. The 110-volt mains are connected to the posts a and b, and the commutator is turned at the rate of 15 to 20 r.p.m. by a screw gearing operated from the pulley k. The capacity of the machine is said to be about 16 amps. in the secondary at 7.2 volts, with 110 volts and 1.5 amperes in the primary. A balancing battery of three cells similar to those composing the groups A and B is connected across the terminals of the low-tension side of the machine to steady its output at the moment when the commutator brushes are changing from section to section.



A SIMPLE DIRECT-CURRENT TRANSFORMER.

Osmium and Thoria in Incandescent Lamps.—There has been so much speculation concerning the use of other substances than carbon in the manufacture of incandescent lamp filaments, and so much interest has been aroused by the latest invention of Dr. Auer von Welsbach that Mr. A. M. Gibson, writing in the (London) "Electrical Review," believes definite information on the subject will be welcomed by all interested in lighting. He describes at length the processes described in the Hungarian patent granted to Dr. Auer, which seems to cover the use of incandescing bodies of osmium and thoria.

Osmium is a metal of the platinum group, the heaviest and most refractory substance known. It is easily oxidized, the tetroxide, OsO_4 being a volatile substance and extremely poisonous. Thoria is largely employed in the manufacture of mantles for incandescent gas lights, and is the oxide of the somewhat rare metal thorium.

Osmium has never been melted. At very high temperatures it goes off in fumes, which burn in the air, forming the tetroxide. It is claimed that it does not volatilize in vacuo or when heated in gases free from oxygen. To obtain his osmium filaments Dr. Auer takes a platinum wire about .0008 inch diameter, which is made to glow in an atmosphere of water vapor and a hydrocarbon, small quantities of the osmium tetroxide being introduced from time to time. A deposit of metallic osmium forms on the wire, but this must be formed very slowly and apparently in a number of very thin layers. The difficulty of obtaining a perfectly smooth coating is very great. When the filament comes from the flashing apparatus it is quite fragile, since the coating contains some oxide. On this account the flashing is driven up to the point when the platinum wire volatilizes and the oxide is reduced, leaving a tube of metallic osmium having the appearance of platinum and quite elas- to draw the platinum wire through a solution of a sulphide or tetra-hydroxide of osmium and then flash it in a vacuum. This operation must be repeated at least 100 times to obtain the necessary thickness of the osmium layer. An electrolytic method is also mentioned, but vaguely. Vegetable or animal fibres can also be employed as the base of the osmium filament, and nitro-cellulose may be used very much in the usual way.

With thoria coatings the phenomena are very interesting. As the energy of the flashing current is increased a dazzling white spot of light appears on the filament and spreads more or less slowly along its length, a minute ball being seen at the same time to spring from the thread. This is due to the volatilization of the platinum core, leaving a tube of thoria which can stand still higher intensity of current. It is curious to note that at a current tension that fuses or destroys any other known substance very little heat is emitted by the brilliantly incandescing thoria filament. Continuing the increase of current strength a point is reached at which the tube bursts with a slight explosion. Its thickness needs be but some tenths of a millimeter. A mere film will answer, in which case the colors of the spectrum appear at one stage of the process. The process for making the thoria filament is hardly a commercial one. A thin platinum wire, of about the size of a cocoon fibre, is drawn through elastic cheeks which are moistened with a solution of a salt of thorium that willl "give an oxide when glowed." A nitrate or a selenate will do this. After each drawing the wire is flashed, and the drawing and flashing must be repeated at least fifty times. To reach perfection the solution used must be very dilute, and the drawing and flashing repeated several hundred times. A compound wire of platinum, osmium, ruthenium and rhodium or iridium is best for the base on account of its high fusing point. In practice the platinum core is not volatilized, the expriment described above simply illustrating the enormous heat resistance of pure thoria. Although not so stated in the specification, alternating current will evidently give the best results, direct currents electrolyzing the filament. No mention is made of an electrolytic way of making the thoria coating, though it is known that by this means a dense, firm coating may be made.

The processes described appear to be still in the laboratory stage of development, and the cost of lamps constructed with any of the filaments mentioned would be very great. The inventor has made no public statement of the efficiencies obtained, but it has been reported that results as low as 1.5 watts per candle have been shown.

PERMANENT MAGNETS.

As the result of a number of experiments Precee found that the mean intensity of magnetic flux in various kinds of magnet steel varies from 1.315 to 2.540 per sq. c.m., the latter figure applying to Marchal steel, the next in merit being Clemandot steel, which retained 2265 lines. As a comparison with electro-magnets, good wrought iron will carry 15,000 lines per sq. c.m.

Electricity as It is Sometimes Understood.

To the Editor of American Electrician:

Having read in a note in the June issue of the amusing electrical definitions given by students, I compiled the following statements and answers of the same character which I have come across in students' note books and examination papers:

A coulomb is the 1-1000 part of an ohm.

A short circuit is a wire of great resistance connecting the main terminals.

Hysteresis is the loss of magnetism when the wire has a static charge.

The internal resistance of a secondary cell is determined by the primary.

The internal resistance [of a cell] forces the current from the zinc to the carbon; while external resistance forces from the carbon to zinc over the outside wire.

All resistançe boxes are regarded in their working as Wheatstone bridges.

A farad is one-billionth of the earth's quadrant.

The difference between voltage and e.m.f. is that the voltage is the amount used and e.m.f. is the time it took to use it.

A magnet that has poles throughout its whole length is said to have consequent poles.

German silver is the best known conductor.

The best known conductor is the earth.

The present accepted theory of electricity is that it is a competition of ether stress.

Electrolysis is an instrument for decomposing liquids.

Electrolysis is the process of obtaining an unlimited number of sparks by the use of a pan filled with melted resin on a dish with an insulated handle.

Electrolysis is the condition of a battery, the elements being consumed so fast the chemicals have not had time to produce the amount called for.

Electrolysis is when the currents tend to act in unison.

Specific inductive capacity is the amount of electricity that will pass a point in one second.

Permeability is that quality of material that permits electricity to be conducted through or over it.

The amount of current a piece of metal of a given size will deliver under given conditions.

Permeability is the electricity that remains on a wire that has been charged and then recharged.

Eddy currents can be laminated.

Field magnets are not laminated "because the eddy currents tend to hold the lines of force straight."

Lamination of armature core is "to collect currents and avoid sparking."

Siemens' shuttle armature: "This armature would heat very easily on account of the lamination, of which they did not know anything about."

The following may be of interest to central station managers: "A compound dynamo is to keep the load uniform."

But the most trying to the teacher, who has carefully explained the principle of the dynamo, is to read in an examination paper that current is generated by the friction of the brushes on the commutator.

C. R. FONTAIN.

Washington, D. C.

Electrical Journals

To the Editor of American Electrician:

The list of electrical periodicals which have joined the great majority, prepared by Mr. Caldwell and appearing in your June issue, seems to be very nearly complete, but men now living should, if possible, contribute towards its perfection.

Among the omissions are a few whose titles and location I can give, but, unfortunately, few other details. "The Electrical Era," published in Philadelphia about 1885, was continued for several months; also, a few years later, "The Message," edited by Mr. Howell, in New York City. "Electricity" was barely started in Cincinnati about 1884. I never saw a copy of it, but it was the name which the late Franklin L. Pope had proposed to adopt for "The Electrician," of which he assumed editorial charge in 1884. Upon learning of the existence of "Electricity" he changed his plans, and his paper was called "The Electrician and Electrical Engineer."

I do not think Mr. Pope had any editorial connection with "The Esquimaux," as he and his party consisted of but four men when he went to Lake Tatla, built Bulkley House and explored the headquarters of the Sticken River in the spring of 1866. "Telegraphica," which is included in Mr. Caldwell's communication, was started by Walter P. Phillips, in New York City, and the literary ability which he displayed in its columns led to his engagement with the Associated Press and his subsequent career in the management of the United Press.

New York. RALPH W. POPE.

To the Editor of American Electrician:

In the list of defunct electrical publications, given by Mr. Edward Caldwell in the June number of the American Electrician, there should be enumerated one formerly published at Rochester, N. Y.—"The Station," monthly, of which only two numbers, January and February, 1896, were issued.

Yours respectfully,
D. L. DAVIS.

Salem, Ohio.

Action of Storage Batteries.

To the Editor of American Electrician:

In a note in the June number under the heading "Lead-Zinc Cadmium Accumulators," the following statement is made: "During charge a deposit of zinc and cadmium is thrown down on the negative plate and a certain quantity of hydrogen is disengaged, which is said to enter into combination with the deposited metals, or, more properly, to be absorbed by them."

I believe there is no doubt that with the ordinary lead plates both oxygen and hydrogen are dissolved by the plates during charge. This may be easily shown by warming the plates after charge, the result being a very large loss of potential. Or a lead plate may be charged by placing it in dilute sulphuric acid with zinc, after which it gives a strong deflection with a lead peroxide plate.

The hydrogen may also be removed by placing the plate in chlorine. In April, 1897, I read a paper on this subject before the National Science Section of the Ontario Educational Association, at Toronto, giving a list of experiments with results, proving, I believe, the preceding statements. SIDNEY SILCOX.

Collingwood, Ontario.

NOTES.

The General Electric Engineering Society.—A society has been formed at Schenectady under the name of the General Electric Engineering Society, with a membership comprising the engineers attached to the several technical departments of the General Electric Company.

The "Canadian Electrical News."—Our Canadian contemporary, the "Canadian Electrical News," issued apropos of the eighth annual convention of the Canadian Electrical Association, held in Montreal on June 29th and 30th instant, a specially interesting number for June, the contents of which serve to illustrate the rapid development of electricity in Canada. Besides illustrations and particulars of the electrical features of Montreal (including portraits of the local committee of the Electrical Association Convention), other articles worthy of mention are: "The Mooted Wireless Telegraphy," by D. H. Keely, superintendent Dominion Telegraph System; "The Cataract Power Company's Works," in course of construction (illustrated); description of C. P. R. copper wire telegraph line from Montreal to Vancouver, B. C., with portraits of officials and superintendents of construction; map showing long distance lines and offices of the Bell Telephone Company.

Soldering Acids and Fluxes.—In a paper read at the March meeting of the American Institute of Electrical Engineers, Prof. R. A. Fessenden said that the ordinary soldering acid, which is a solution of chloride of zinc, is harmful to cellulose fabrics, which it turns into a paste. It never evaporates, but always takes up moisture from the air, and will gradually eat its way through quite a thickness of insulation. Whether it is acid or neutral makes no difference, so far as its action on the insulation is concerned, though the neutral solution does not corrode the wire. Rosin has the disadvantage that it is not a fluid and it is clumsy to handle. Prof. Fessenden found that by shaking up powdered rosin in very strong ammonia, an ammonia soap is produced which works well in most cases; the ammonia dissolves the copper oxide and evaporates afterward, leaving the powered rosin, which is an insulator.

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The Chicago Convention.

Perhaps the most distinguishing feature of the Chicago convention was its business-like character. The administration of President Insull produced not only an interest in the association and the convention itself, but resulted also in the preparation of one of the most excellent programmes of papers ever presented to that body. While there was no paper of an academic character, and none of deep technical interest, the importance of the topics chosen and the sensible and conservative manner of their discussion mark this convention as one in which the association realized fully the objects of its existence, and directly and indirectly benefited the industry it represents.

One of the papers, that of Mr. Dow on the question of municipal ownership, marks an era in the evolution of the attitude of the electric light man toward this all-important matter. Mr. Dow's argument may be summarized in brief as an exposition of the facts; that a municipality has the right to engage in public lighting if it pleases; that it has not the right to engage in private lighting; that a private corporation engaged in private lighting can, under proper and equitable conditions, furnish the municipality its public lights in addition at a less cost than the municipality itself can make them. From these premises the conclusion that public lighting is best done by a private company and that the establishment of a municipal plant is a fallacious enterprise are irresistible. But it is neither to the argument nor the conclusion that the greatest attention will be directed, but rather to the admission that a municipal corporation has the right to engage in the electric light business. Unfortunately for the ideas of those reformers who advocate municipal ownership in and out of season the admission will not seriously strengthen their cause, as the folly of municipal ownership is made as evident as its propriety. That the entire membership of the association will agree with Mr. Dow in the somewhat altruistic ideas he advanced as to the profit to be demanded by electric contractors is not, of course, to be expected, but there is much food for thought in his suggestions, and more in the fact that there seems to be a tendency to establish the basis for dealings between electric light companies and municipalities on equitable grounds. In Mr. Insull's presidential address much the same variety of ideas were prominent, and it is much to be hoped that these are indications of the trend of opinion in the electric lighting fraternity at large.

The time-honored question of the proper variety of current, direct or alternating, for central station supply, brought forth two excellent papers, the advocate of the alternating current, Mr. Wagner, having naturally rather the better argument. The fundamental idea in this paper was that the system of direct-current supply so carefully and intelligently worked out in the past few years, is equally available for the supply of alternating current, while there is no superiority of the direct over the alternating current in any particular save that of age and establishment. The flexibility of the single-phase system of supply, especially when adapted to the feeder and main method of distribution, and the high station efficiency that can be attained by this method, were strikingly brought out.

In Mr. Ferguson's paper the data of the supply system of a great electric lighting company, while rather staggering as to magnitude of figures, were very interesting. Perhaps the main feature of his paper is the elaborate discussion of the storage battery as a factor in distribution and station economy. A fact that has escaped general notice was pointed out by Mr. Ferguson when he stated that accumulators are valuable in systems whose load curve has an average peak of not more than two hours in width. The battery is rated by the h.p. or k.w. hour, and its cost increases in direct proportion with the time that it is to carry the peak load, while the steam engine and dynamo are rated by their output capacity, and cost no more if they are to work continuously than if they are to operate only at the moments of heaviest load on the station. Consequently, if the battery is to carry the full peak for seven or eight hours a day, its cost will be enormously in excess of steam machinery for the same purpose. This, however, does not state the whole case, nor can this fact well be used as an argument against the accumulator, since the greater cost of the latter may well be compensated by the economy introduced through its action in keeping the generating units fully loaded and working at their maximum economy.

In the discussion of Mr. Rice's paper the fact that the system of charging for current based upon the maximum demand of the customer, in its relation to the output of the station, has become the standard, was apparent. Only a year ago the association discussed this method of apportioning charges, and the idea seems to have made gratifying progress, if not in execution, at least in the manner of its reception. It is becoming evident, to quote President Insull, that central station managers should sell electric current to "the greatest number of consumers at the lowest possible price," and notwithstanding make a profit.

The further extension of electric lighting is largely a matter of the price that the consumer has to pay, and it is only through some system of really equitable charge that the burden of cost is reduced for the profitable long-hour customer and the use of the light popularized.

The report of the committee on standard candle-power of incandescent lamps contained the discouraging information that the 16-c.p. lamp of commerce is not a 16-c.p. lamp, after all. It is to be hoped that when the recommendations of the committee are carried into effect this state of things will be less prevalent. Strangely enough, not a word was said at the convention about high-voltage lamps, but this is hardly to be taken as an indication that that subject has lost its perennial interest.

The Northwestern Electrical Association.

The excursion of the Northwestern Electrical Association on the steamer "Northwest" will be memorable from its social features, and the close association of the delegates was conducive to exchanges of information and comparison of experiences that could not fail to be of value. The papers can scarcely be said to measure up to the usual standard of the association, and the same is true of the discussions. Exception should be made of the paper by Mr. W. B. Snow on "Forced Draft," which presented in an able manner a subject which is of growing importance to central station men. Elsewhere in this number will be found abstracts of all the papers read before the convention.

Carbon Filament Resistance.

At the meeting of the Northwestern Electrical Association the information was brought out that incandescent lamps are in successful commercial use replacing the resistances employed with constant potential arc lamps, the light from the filament being utilized in hallways and elsewhere where its necessarily variable character will not be objectionable. Where the circuit is of 125 volts and inclosed arcs are used, 50-volt 16-c.p. low-efficiency lamps should be suitable for this purpose, six being used in parallel for a 6 amp. arc. In this case the lamps would glow normally at nearly full candle power, and thus give almost 100 c.p. of light, which otherwise would merely be wasted as heat in the usual metallic resistance. This is but another instance of the value of the carbon filament for use as a resistance, but it is in connection with alternating currents that its superiority stands out in strongest relief. Owing to its high specific resistance for a given amount of energy dissipated the lines of force inclosed by the loop of an incandescent lamp are relatively extremely small in number, so that as an alternating current flowing in the filament rises and falls in value, the inductive e.m.f. due to the cuttings is negligible in any practical case. In other words, an incandescent lamp filament is practically a non-conductor resistance, which is a precious advantage in some cases.

Powering Small Craft.

The article elsewhere in this issue on the determination of the power and the diameter and pitch of screw for the propulsion of small boats, is one of the most complete presentations of the subject yet written. An important point brought out is that a definite relation exists between the speed and diameter of a screw, and that a high slip may correspond to a maximum efficiency. That is to say, as the revolutions become higher the diameter should be decreased, though this latter operation increases the slip. These facts have long been known to marine engineers, but from the stress often laid on small slip it is well to call attention to what is sometimes considered an anomaly. Another point referred to is that in ordinary cases a four-bladed screw is suitable, but should it be desirable to use one of two or three blades this will be indicated by the results of the calculations made to determine the screw data. It may thus happen that with an electric motor of high speed a three-bladed propeller will be the more efficient, but the determination of this point can be made on an intelligent basis instead of being left to mere surmise.

Owing to the very considerable weight of storage battery required for power, electrically propelled boats are limited as to speed, and should be carefully designed with respect to lines so as to reduce to a minimum the power required for a given speed. As to size, the weight of battery increases at a less rate than the displacement; for example, if the displacement is doubled the power to propel the larger boat at the same speed is only increased about 1.6 times. On the other hand, the elements of first cost and depreciation tend to keep down the size. The question of speed is the serious matter, since the watt-hours of electrical energy required to go over a given distance, and consequently the weight of battery at same rate of discharge, increases as the square of the speed. That is, to travel over 25 miles in two and one-half hours will require four times the watt-hours necessary to cover the same distance in five hours, or at half the speed. The amateur who wishes to possess an electric boat will usually find that a small craft, accommodating not more than three or four persons, and having a speed of not over 5 miles per hour, will be sufficiently expensive to satisfy his desire.

Seeing by Electricity.

For several months past the daily press has been printing paragraphs from time to time concerning a wonderful invention by a Bohemian schoolmaster laboring under the name of Szczpanik, by means of which, it is claimed, a picture can be transmitted by means of electricity. Judging from the accounts thus far printed, the inventor can be welcomed as a new accession to the ranks of the wizards, for after describing in most glowing terms the possibilities of his invention, he confines the explanation to a few generalities, with the statement that full publication is reserved for 1900, when the apparatus will be exhibited at the Paris Exhibition. As described, the light from the object whose image is to be transmitted is thrown on a selenium screen which gives rise to electric currents that reproduce at the receiving end an image duplicating the one at the sending end. The explanation which the inventor gives is principally confined to a description of an arrangement of reflectors whereby the light as it appears on the screen is broken up into squares, and which causes the image to appear and disappear fifty or more times per second. No reason is given why the image should thus be treated, but the description of the action of the reflectors is highly scientific in phraseology and undoubtedly satisfactorily impresses the lay reader. As to the further steps—how the electric currents are generated by the spots of light, how their quantity is proportioned to the intensity of the light, and how at the receiving end the currents produce the effect of light—this information is reserved for 1900, with the exception that selenium is mentioned as one of the agents used in the process. The fact that the resistance of selenium changes with the intensity of the light to which it is subjected has long been known, and many attempts have been made to utilize this property in the transmission of light effects. The Bohemian schoolmaster has probably worked up his story from this basis, adding wizard effects to dazzle the understanding of the lay reader and render the tale enticing to the wonder loving.

DESIGN, CONSTRUCTION AND TEST OF A 2 1-2 K.W. THREE-PHASE, TWO-PHASE TRANSFORMER.

BY PROF. A. F. MCKISSICK.

A very interesting and instructive article by Prof. Henry S. Carhart on the "Design, Construction and Test of a 1250-watt Transformer" appeared in a weekly electrical journal some months ago. The work having been done by two of Prof. Carhart's students under his direction, with the idea of determining how far theory dictated correct practice, it was with this same idea in view that two of my students, Mr. T. G. Conner and Mr. B. S. Patrick, undertook, under my direction, the design, construction and test of a three-phase, two-phase transformer and the results obtained are due to them.

The method of design was taken from Bedell's "Principles of the Transformer," and is due to Prof. Harris J. Ryan of Cornell University.

In a paper read by Mr. Charles F. Scott in 1894 before the National Electric Lighting Association there was described a method of transforming currents of one phase into currents of a different phase, as follows: "If two e.m.fs. differing in phase 90 deg. be connected in series, the resultant e.m.f. is represented in direction and magnitude by the hypothenuse of a right-angle triangle, of which the two sides are the two component e.m.fs. Thus in Fig. 1, if AO and OB are two e.m.fs. at right angles, and these e.m.fs. be connected in series, the resultant is the line AB, of different phase from either of the components. It is a simple matter to so proportion the components that OB is equal to one-half of AB, as shown in the diagram. In a similar manner it is readily seen that the same e.m.f., OA, may be combined with OC, which differs from it by 90 deg. (but is equal and opposite to OB) in such a way as to give AC equal to AB, but differing in direction. BO and OC added together give BC. The e.m.f., BC, may, therefore, be combined with the e.m.f., AO, at right angles to it, in such a way as to give additional e.m.fs., which in connection with BC give three equal e.m.fs. 120 deg. apart.

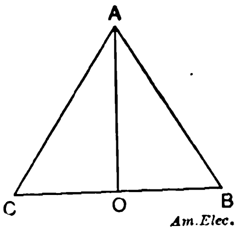


FIG. 1.—E. M. FS. OF PHASING TRANSFORMER.

This is the relation of e.m.fs. in the three-phase system.

"The application of this arrangement to transformers is illustrated in the accompanying Figs. 2 and 3. The primaries of two transformers are connected to a generator giving two-phase current. The secondary e.m.fs., therefore, differ 90 deg. One secondary is made equal to 100 turns, and a loop is brought out at its middle point, giving 50 turns at each side. The second secondary has 87 turns, which is approximately equal to 50 multiplied by the square root of 3. One end of the secondary circuit is connected with the middle point of the secondary of the first transformer, as shown, and the three free terminals will then deliver e.m.fs. differing in phase 120 deg. If the e.m.f. on each primary be 1000 volts, and on one secondary 100 volts, and on the other 87 volts, then the e.m.f. measured between any two secondary terminals will be 100 volts."

Design.—Three-phase current, 220 volts, 133 cycles, to be transformed to two-phase current, 500 volts. Transformer to be 2.5-k.w. capacity, Ferranti type.

The apparatus may be said to consist of two single-phase transformers of equal output practically (1.25 k.w.). The transformer connected to two three-phase mains (BC in Fig. 2) is known as transformer "A," the other as "B."

Transformer "A."--To find the maximum magnetic density (B max.) used in Prof. Ryan's formula, B max. $= 3050 - \dfrac{P_2}{20} = 2990$ where P_2 is output of secondary.

$$\text{Primary turns } (S_1) = \frac{E_1 \times 10^4}{\sqrt{1.11 \times n \times P^2 \times B\ \text{max.}}};$$

n = 133 cycles; therefore, $S_1 = 93.6$.

93.6 is, theoretically, the proper number of turns to use, but this would give a fractional number of turns on the secondary, as the ratio of transformation is 11 : 25. For this reason 88 turns were used on the primary, and consequently 200 turns on secondary, since $S_2 = \dfrac{S_1 \times E_2}{E_1} = 200$.

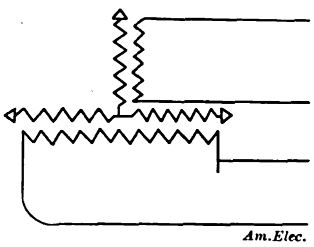


FIG. 2.—TRANSFORMER "A."

To find the cross section of the magnetic circuit in square c.m.s. (A), use the formula:

$$A = \frac{E_1 \times 10^8}{4.45 \times n \times S_1 \times B\ \text{max.}} = 141.3 \text{ sq. c.ms.} = 21.9 \text{ sq. ins.}$$

Assuming 90 per cent of the core is solid iron, we have for total cross-section of core $21.9 \div .9 = 24.3$ sq. ins.

Design of Coils.—Secondary current $= \dfrac{P_2}{E_2} = 2.5$ amps.; primary current $= \dfrac{S_2 \times I_2}{S_1} = 5.7$ amps. Allowing 1200 cir. mils per ampere, then cross-section of secondary $= 2.5 \times 1200 = 3000$ cir. mils, equivalent to No. 15 B. & S. wire. Making the same allowance in primary, its cross-section $= 5.7 \times 1200 = 6480$ cir. mils, or No. 12 B. & S. wire. Diameter No. 15 B. & S. wire (insulated) = .08 in. Secondary copper space $= 200(.08)^2 = 1.28$ sq. ins. Diameter No. 12 B. & S. wire (insulated) = .104 in. Primary copper space $= 88(.104)^2 = .95$ sq. in. Total copper space $= 1.02 \times 1.28 = 2.23$ sq. ins.

A bobbin of micanite 3¾ ins. long, cross-section 4⅜ ins. by 5 ins., was used for winding the primary and secondary coils on. Width of winding space, 3.5 ins.

Number of wires per layer in secondary coil $= \dfrac{3.5}{.08} = 44$. Number of layers $= \dfrac{200}{44} = 4$, with 24 turns on a fifth layer. Number of wires per layer in primary coil $= \dfrac{35}{.104} = 33$. Number of layers $= \dfrac{88}{33} = 2$, with 22 turns on third layer. Primary coil wound on top of secondary.

Losses.—Volume of iron core = 373.35 cu. ins. = 6122 cc. Assuming that a hysteretic coefficient .0024, hysteresis loss $= \dfrac{6122 \times 133 \times .0024 \times 2990^{1.6}}{10^7} = 71$ watts. To calculate the copper losses of secondary coils, we have: Length of inner turn = 19.75 ins.; length of outer turn = 22.95 ins., or an average length of 21.3 ins. Total length of secondary winding, 355 ft.; resistance, 1.14 ohms. Therefore, heat loss $= (2.5)^2 \times 1.14 = 7.12$ watts.

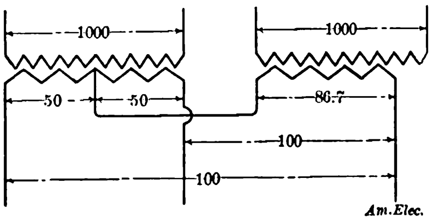


FIG. 3.—TRANSFORMER "B."

The average length of one turn of the primary winding = 24.25 ins.; total length of primary winding = 178 ft.; resistance, = .28 ohms. Heat loss $= (5.7)^2 \times .28 = 9.09$ watts. Losses at full load $= 71 + 7.12 + 9.09 = 87.2$ watts. Efficiency $= \dfrac{1250 - 87.2}{1250} = 93$ per cent.

Design of Transformer "B."—As the secondary of transformer "B" has the same number of turns as the secondary of transformer "A," and as the same e.m.f. is generated in each secondary, we will assume that the magnetic density is the same in each. Therefore they should each have the same cross-section of iron. The bobbins for the coils then should be of the same size and the coils are the same except in number of turns. The secondary of this transformer (B) should have 200 turns, and the primary $\dfrac{88\sqrt{3}}{2}$, or 76 turns.

The two transformers were so similar that only a slight error was made in assuming that the losses in them are the same.

Construction.—The Ferranti type was decided upon because of the ease of construction. Two micanite bobbins were fitted with wooden blocks so that they could be placed in a lathe and wire wound upon them. After the wire was wound, the wooden cores were removed and the iron put in place.

Material Used in Transformers.—Five hundred tweny-four plates of sheet iron were used, 5 ins. wide, .015 in. thick, and varying from 16 to 32 ins. long; two bobbins, cross-section 4⅜ ins. by 5 ins., length, 3.5 ins.; 710 ft. No. 15 B. & S. wire for secondaries; 356 ft. No. 12 B. & S. wire for primaries. The iron used in these transformers was purchased from a dealer and was supposed to be good transformer iron, but subsequent tests proved it to be inferior iron.

Tests.—Two methods were used for measuring the efficiency of the transformer; one, by measuring the input and output, the secondaries being loaded with incandescent lamps, and the other by measuring the iron losses and copper losses for varying loads.

The iron loss was found by measurement to be 241 watts, which differs greatly from the calculated value of 142 watts. This explains the rather low efficiency obtained and also shows that the hysteretic coefficient was .0042, instead of .0024, as assumed.

The copper loss was found by measurement 35 watts at full load, which comes near the calculated value, 32 watts.

The drop in voltage from no load to full load amounted to 4.6 per cent.

Results of Efficiency Tests.— The curves give the values of real and apparent efficiencies for varying loads. In the real efficiency curves the small circles mark the points obtained from the results of the first method, the crosses the results of the second method.

◆

DYNAMO TESTING.

CONVERTED LOAD RESISTANCE.

In previous articles a number of methods of dynamo testing were given, with which an adjustable resistance was necessary. Water resistances will frequently answer every purpose where accuracy and constancy are not essential, but they are a make-shift, and where much testing is to be done, as in the testing rooms of factories, it is best to have a large wire resistance, divided into sections which can be thrown in series or multiple, according to the character of service to be performed. To meet this demand, the writer has found the arrangement described in the following paragraphs very convenient:

Postponing for the moment the actual construction of the resistance itself, the connections will be considered. The resistance is arranged in series, and leads are brought out at equal intervals, as shown in Fig. 1. The wire to be used is preferably a low grade steel wire about No. 14 B. & S. This has a higher resistance than iron wire, and will comfortably carry ten amperes. When a greater load is to be carried, it is met by multiple connection of the sections, as will be shown later.

The leads passing out from the resistance are connected to the middle blocks of double pole, single throw ten ampere switches, of the type shown in Fig. 2. These switches need only be of the roughest kind, as almost any knife switch will carry ten amperes. Indeed, it is not a question of amperes, but of volts, the arcs that are formed at the switches when manipulated being the principal thing to contend with. By proper management these can be almost entirely avoided.

The single-pole switches are arranged to have their jaws connected to common bus-bars, as shown in Fig. 3. A resistance thus arranged may be connected in anv way desired.

For loading arc machines, a high pressure is necessary, and the switches would be thrown as in Fig. 4. If the resistance of each section were about 11 ohms—a convenient value on account of other considerations—each section would add about the equivalent of two arc lamps to the load. In using the rheostat for arc loads, the load may be easily increased or diminished without breaking circuit, by taking care to throw the switch which is to connect for the new load before opening the other. Indeed, it is not necessary to do even this, as all of the switches may be thrown on to the upper bus, with the exception of one at the end, which is thrown on to the lower bar. The load may then be varied by opening the switches on the upper bar, beginning with that next the switch thrown on the lower bar. Care should be taken not to throw the last switch, thus breaking circuit, for a serious arc would result.

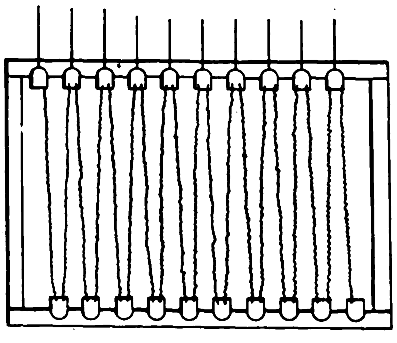


FIG. 1.—FORM OF RESISTANCE.

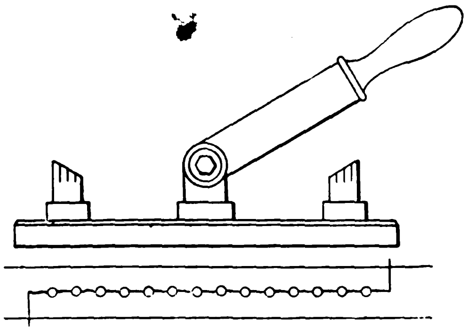
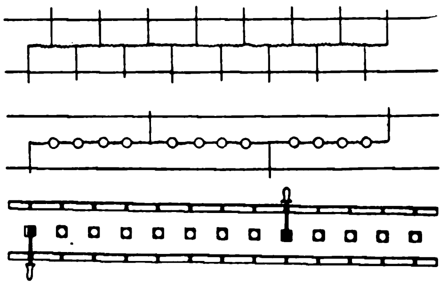


FIG. 2.—TYPE OF SWITCH.

For testing incandescent machines, the switches should be arranged as shown in Fig. 5. Alternate switches are thrown on to the same bar. The sections are thus in multiple with each other. Being of 11 ohms resistance each, the current in them cannot largely exceed ten amperes when subjected to incandescent lighting voltages. For 220-volt testing, every other switch should be thrown alternately on to the bars, thus connecting two sections in series across them; and for 500-volt work, every fifth switch should be thrown, as shown in Fig. 6. In all of these cases, with the exception of the arc machine method, every switch thrown adds an increment of ten amperes to the load. If the single-pole switches are deemed too expensive, the wires coming from the rheostat resistance may terminate with a flexible lead and plug. The two copper bus bars may then simply carry taper holes which fit the plugs. The flexible lead is of sufficient length to allow each plug to be inserted in either bus at will, and it is easy to see that this arrangement will completely replace the switch system described.



FIGS. 3, 4, 5 AND 6.—METHODS OF USING RESISTANCE.

It will be found best to have the leads emerge from symmetrically spaced holes between the bus bars to avoid confusion. Dummy holes should be provided to contain the plugs when not in use, for if they are allowed to swing, a slight disturbance might provoke a brilliant, and perhaps serious, pyrotechnic display, both at the switchboard and at the machines to be tested.

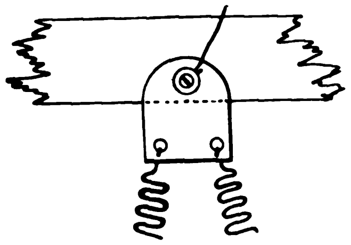


FIG. 7.—DETAIL OF RESISTANCE FRAME.

The construction of the resistance itself is worth a few remarks. A convenient method is to string it on rectangular frames, as shown in Fig. 1. Brass pieces are screwed to the frame at proper intervals, and to them the connections are made, as shown in Fig. 7. The wire is preferably coiled in long spirals, which have sufficient tension to hold the simple hook contact sufficiently tight for the purpose, and this method admits of the ready renewal of the spirals. Six feet is a convenient width for the frames, which may be conveniently hung from the ceiling of the testing room. They should be thus hung in pairs, allowing sufficient space between the pairs to remove a coil if necessary.

For testing alternators, the load which such a resistance would impose, would be too inductive, and it will be found better to use lamps. These may be arranged in parallel banks of ten, as shown in Fig. 8. The leads, L L, pass to a switching system such as has just been described. There should be at least eleven leads and eleven switches.

If the system is well insulated, it may then be thrown on the mains of a 1100-volt machine by simply using the two end switches, but unless some of the lamps are unscrewed from their sockets, this will throw one hundred lamps across the alternator terminals. It is not enough to unscrew the lamps at random; an entire row of ten must be unscrewed if it is desired to reduce the load and this is a disadvantage. It is, however, more common to use a transformer giving 110 volts, and in such a case the switches are thrown alternately on to either bar, each switch controlling a bank of ten lamps. Even when using a transformer, the load will be non-conductive, provided the transformer is fully loaded.

In large testing rooms it is customary to have numerous pedestals on which to test the machines as they come in from the assembling department. They are suitably arranged for convenience in making belted connections to the counter shafts or to calibrated motors, and means are provided to secure the machines firmly to them. It is too frequently the case that a table or box is placed near the machine, and the instruments are arranged upon it, or perhaps on the floor near by. This slipshod arrangement can be replaced by the following convenient and practical device:

From each pedestal should come six wires. Two of these are the output wires, two for a shunt ammeter circuit, when there is one, and two more for a voltmeter circuit. A slate table is provided carrying six sockets for each machine. These sockets are adapted for plug connections. Four of them interrupt the main machine circuit, which can then be completed by a jumper on one side and ammeter connections on the other. The other two sockets form the terminals of the shunt wires coming from the machine, and are usually bridged by an ammeter. The voltmeter wires pass to two insulated binding posts, preferably just under the edge of the table. The load circuit passes on from the testing table to sockets, where it can be conveniently connected to the rheostat by plug connections. The rheostat should be conveniently near the table so that it may be manipulated in accordance with the indications of the instruments.

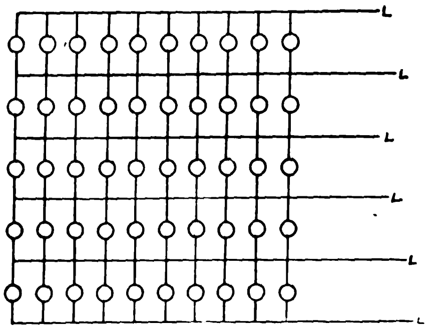


FIG. 8—LAMP RESISTANCE.

Fig. 9, which shows a plan and perspective of this arrangement, will materially assist in making the scheme plain. By this means the electrical manipulation is entirely separate from the mechanical handling of the dynamo, which is a great advantage. Very frequently accidents have happened, such as the coming off of a heavy belt under a sudden load, which have swept a whole table of expensive instruments to destruction. In factory testing the machine is usually given a very hard trial, and those in immediate attendance upon it must give it their entire attention, and those who are recording and reading the instruments must not have their attention distracted. The arrangement described permits these conditions to be realized in a very high degree.

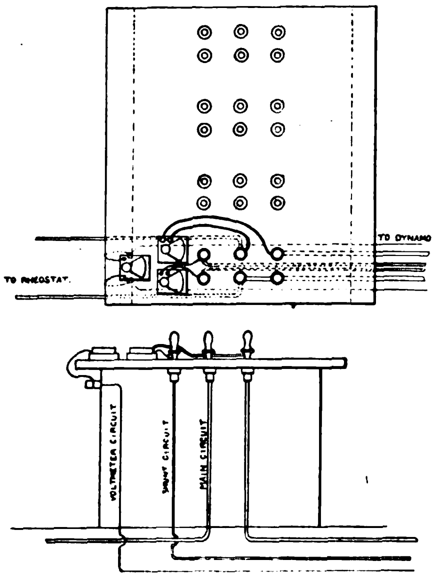


FIG. 9.—TESTING ARRANGEMENT.

◆

CHANGES IN ELECTRIC WIRING.

BY HARRY N. GARDNER.

If one stops to think of the development of electrical industries during the last decade, what a host of changes in the methods of doing work in all departments of the business at once come to mind. One branch of the work in which there have probably been as many changes made as in any other is the system of interior electric wiring for light and power; although perhaps many engineers would not consider the developments that have come to this department worthy of being numbered with the great advancements of the science. A competent wireman, however, cannot repress a smile when he thinks of the manner in which certain work was done but a few years ago; while an examination of that work is sufficient to crowd the dreams of an insurance inspector with nightmares.

It seems almost like the barbaric age of the industry to think of running electric light wires unprotected through the plaster and over the iron or steel frames of large buildings as was done but a few years ago, and "undertakers" wire at that; and yet I believe that such a modern building as the large Auditorium in Chicago has the wiring done in this manner. But before such work is criticised too severely, it must be remembered that many business blocks in all of the large cities were thus wired, and that the service is in many cases still in use, and that little trouble has been experienced from what now seems almost like suicidal methods. No one at all informed upon the subject can help wondering that there has been so few fires caused from imperfect electric wiring; although it is well known that many conflagrations are unjustly attributed to this cause.

It is largely owing to the requirements of the insurance companies, who realized the dangerous possibilities of the new method of lighting and power service, that many of the improvements have been made in the method of interior wiring. While these dangerous possibilities exist, it must be claimed for electric lighting that when wiring is properly done, it offers the safest system of lighting yet devised by man. This assertion is made, notwithstanding the complaints of insurance inspectors, who sometimes, while pointing out defects in wiring to property owners not informed upon the subject, do so in such a manner that the idea is at once conceived that the "juice" is the most dangerous thing that a man can have around his premises.

When it became apparent that the method of running wires, even though they were insulated, unprotected and in contact with timbers and walls, was an improper one, it was found that they could be removed from timbers by the use of porcelain insulators. This was an excellent method as far as it went; but it was still found that it did not help matters in large business blocks where no timbers were used. When some one thought of an insulated interior conduit, he was hailed as the genius of the industry, and there were many instantly ready to credit his product with being the ne plus ultra of the art. There were many things that could be said in favor of the brass armored conduit that jumped at once into favor; although within half a decade its defects became so apparent that some of the very inspectors who a few years ago were demanding its installation in almost all cases are now forbidding its use in any form.

Because inspectors said that "brass armor" was a good thing in some cases, there were plenty of wiremen, who did little thinking for themselves, ready to consider it the essential that "filled the bill" in every particular. Two and a half years ago an isolated plant was being installed in a large brewery. The wireman in charge of the work was one of the above class of workmen. An open system of wiring was followed, and on the whole the work was well done; but whenever any contingency arose that presented difficulty, "brass armor" was always the only remedy to be applied. If an iron pipe had to be crossed, a piece of "brass armor" was slipped over the wire and the difficulty was solved. In one case it was necessary to pass through a two-foot wall of the cold storage, where the wooden sheathing on either side was lined with sawdust which was decidedly moist. No porcelain tubes of the right length were at hand and of course a piece of "brass armor" was cut off and used, notwithstanding the fact that any one who has observed knows that this conduit is not impervious to moisture. The utmost care was taken in all cases to keep the wires removed at least an inch from all wood: but in one case where this conduit was used to protect the wire at a grounded pipe the conduit was broken as it was bent over the pipe, so that the insulated wire necessarily came in contact with the grounded pipe. The inspector who passed upon this work said that it was the best piece of work he had ever seen.

An inspector of another district in another State, who always makes arbitrary rules of his own no matter what the regulations adopted by the underwriters' board may say, would not permit circular loom tubing to be used two and a half years ago, but favored brass armored conduit for almost every purpose. Now the brass armor will not go, but circular loom tubing is all right. Not long since workmen were observed running a row of side lights down a brick wall for a show window. Circular loom tubing was being used, but instead of bringing the tubing out at the outlets, short pieces of wire were tapped on to the circuit at these points, pieces of the tubing were slipped over the wires between the outlets, where the soldered joints were merely taped, and short pieces of tubing were slipped over the short projecting "taps," and the whole left to be plastered over in this manner. A certificate for this work was signed by this inspector, who thirty months before was so in favor of brass armored conduit, and would not permit the use of circular loom tubing, and who then declared: "There is only one right way in which work should be done, and that is the manner in which I want it done."

After the brass armored conduit came the iron armored; and that likewise soon found advocates who were in favor of its use for all kinds of work. Of this system of wiring it can be said that in those places where wires must be run along untimbered walls and ceilings, it is probably the nearest to perfection of any system yet devised, when it is properly installed.

As to the question which has recently caused so much controversy in electrical papers, the relative merits of insulated or plain iron piping for wire conductors, it seems strange that any thinking persons, experienced in the business, should for a moment favor the use of plain gaspipe for this purpose. A few reasons for this opinion are because no pipe as made is perfectly smooth on the inside, and in drawing wires into an uninsulated pipe the rough places are liable to abrade the wires, and a short circuit or grounded wire will result. Again, good engineering practice demands that for all classes of work the factor of safety shall be kept as great as possible, and who will say that this factor is not greater by the use of the lined pipe? It may be said that such a pipe will answer all requirements in 999 cases out of a thousand, but it is that thousandth case that the good engineer is always looking out for. Any observer knows the liability of the insulation of wire to crack with time, especially if kept in a dry place; and if such cracking results in an uninsulated pipe, the liability to cause trouble is increased just that much. It may be said that even if trouble does occur when the wires are incased in an iron pipe, that there can no serious results follow; because if there is any heating the wire is so inclosed in noncombustible material that it can set nothing afire. Suppose, however, that it happens that the wires have come in contact with the iron piping so that a short circuit is formed, the pipe acting as part of the circuit. It frequently happens in the way that joints in the pipe are made, assisted by later oxidation, that some part of the pipe itself offers greater resistance than does the wire, and if any heating results it is outside instead of inside of the pipe.

Even with the use of insulated iron conduit, greater care should frequently be taken in the manner in which it is installed. In many cases the ends of the pipe are not reamed with a "butt" reamer, as should always be done. In cutting off the end of a pipe in the ordinary way there are almost sure to be burrs or fins left, often in such a manner that they project through the insulation and leave a sharp point to cut the wire insulation when it is drawn in. Again, when lead is used for making the joints, it is frequently applied to the ends of the pipe before it is entered in the sleeve, or else it is daubed into the sleeve itself and the ends of the pipe screwed in. Either one of these methods is almost sure to result in the lead being squeezed in through the insulation, so that a metallic contact is made between the pipe and the wire insulation, which partly nullifies the good accomplished by the insulation. The end of the pipe should always be entered for a thread or two into the sleeve, and the lead then carefully applied.

There are many advocates of the iron armored conduit that now hold, as did the advocates of the brass armor a few years ago, that all wiring shoud be done in this manner. Where wiring is to be done for a fireproof building, or one where there are no timbers or where wires are run along brick walls, all good engineers will admit that the system is the best; but for residences or business blocks where wooden floor joists or studding are used, it is doubtful if there has yet been a method of wiring suggested that offers the real safety that does simple porcelain knob and tube work.

Of course, it must be admitted that such work to be safe must be properly installed; but the same can be said about iron armored or any other kind of work. Careless workmen are just as liable to put in iron pipe in an improper manner as they are to screw up knobs or make a tie as it should not be done. One case in mind is work done by a large contracting firm, which tried to convince its customers that all wires should be inclosed in conduit, and who did iron conduit work by running separate pipes for each wire, and that where an alternating current would have to be used.

One objection sometimes made to running wires unprotected between floors on porcelain is that mice will eat off the insulation. Even suppose that does happen, is there as much danger from this as there is when the wires inclosed in an iron pipe come in contact with the pipe? And is there any real danger if the wires are thus exposed? If it is possible for the mice to get at the wire it is proof that it is surrounded by no better conductor than air. Probably the most serious criticism that can be made against porcelain knob and tube work is that there is danger of a wire being weakened in tying, so that, while it is not broken entirely off, its resistance is so increased that if there should be heating in any part of the wire it would come at that point. Even should that happen, it is sure to be at a point where the wire is well supported upon one of the most incombustible of materials.

Every one knows that clear air is as good a non-conductor as can be asked for; and if work of this kind is properly installed, every wire where it passes through timbers is kept from them by a substance as incombustible as iron pipe and a non-conductor instead of a conductor. While it is undoubtedly better to keep wires from coming in contact with wood in any way, there can no real harm come unless in some manner the wire becomes heated, while if two wires come into contact with the iron piping trouble of some kind is pretty sure to result.

The habit of economizing in the use of porcelain as practiced by some contractors is a bad one; but at the same time the new rule of the underwriters, requiring that knobs must be placed not more than four and a half feet apart, appears to be stretching the point about as far the other way. There are many places where knobs should not be placed even a foot apart, and there are many other places where every six or even eight feet is plenty close enough.

Another thing that can be urged in favor of porcelain work wherever it can be used is its cost. It is undoubtedly true that one thing that has kept electric lighting from being used in many cases is the cost of installing the wires; and an effort should be made by all people who have the interest of the industry really at heart to make such work as cheap as is consistent with its proper installation. But all things being equal in the two kinds of work, in a wooden timbered building, the writer believes that porcelain work offers greater safety than any method yet devised.

RESISTIVITY OF GLASS.

The resistance of glass varies widely with temperature. If taken at unity at 68 degs. F., the resistance is .077 at 142 degs. and 87 at 0 degs. At the latter temperature glass has a resistivity of 5000 million million times that of copper.

AMERICAN TELEPHONE PRACTICE.

SELF-RESTORING SWITCHBOARD DROPS.

KEMPSTER B. MILLER.

It is obviously of very great advantage to have switchboards so arranged that it will be unnecessary for the operator to manually restore the drops. When it is considered that every movement on the part of the operator, in establishing a connection between her telephone and that of a subscriber, or between two subscribers' telephones, requires a certain amount of time, and that in the busier portions of the day an operator is worked almost to the extremity of her endurance, it will be clear that the saving of any movement or movements in the establishing of these connections will be a great gain in the rapidity with which the board can be operated. Such saving of the work of the operator not only insures a quicker and therefore a better service, but also reduces the cost of the operation of the exchange by enabling fewer operators to handle the system.

Brief mention has already been made in preceeding articles to the electrically restoring switchboard drops, used to a large extent by the licensees of the American Bell Telephone Company in this country and abroad. The details of such a drop are shown in Figs. 1, 2 and 3. In Fig. 1 a is a tubular electro-magnet, carrying on its rear end an armature c, pivoted at c^1, which armature carries an arm c^3, which projects forward and is provided with a catch c^4 on its extremity. So far the arrangement is almost identical with that of the Warner tubular drop already described in this series. A second tubular electro-magnet d is secured to the front of the plate b, which also supports the magnet a. This second magnet has its poles facing the front of the board. An armature e is pivoted at its lower side by the pivots e^1 and e^2, shown in Fig. 3. The catch c^4 on the rod c^3 is adapted to engage a lug e^3 on the armature and retain it in its vertical position. Pivoted on the bracket f, which is insulated from the magnet by the strip of insulating material f^1, is a light shutter, g. The tendency of the armature e when released is to fall outward, and in so doing it presses against the light shutter g just below its pivotal point, and forces it into a horizontal position.

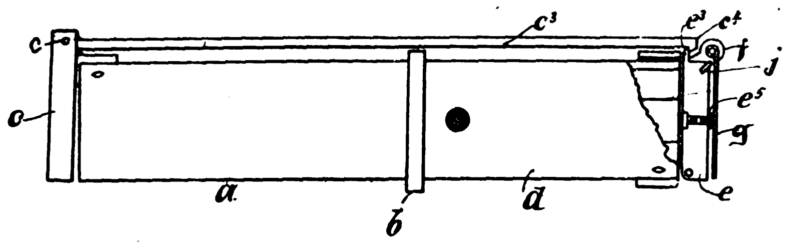
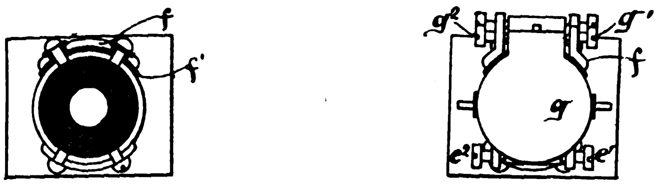


FIG. 1.—DETAIL OF SWITCHBOARD DROP.



FIGS. 2 AND 3.—DETAILS OF SWITCHBOARD DROP.

The coil of the electro-magnet a is usually termed the actuating coil, and is included in the circuit of the line wire. The coil of the electro-magnet d, termed the restoring coil, is in a local circuit containing a battery which is closed by the insertion of a plug into the spring jack of the line belonging to that drop.

Various arrangements associating drops of this type with the line circuits and with the local circuits at the exchange have been devised and put into practical operation with almost unqualified success. The arrangement in Fig. 4 is typical, and at the same time shows a very interesting improvement designed for saving battery power in the exchange. The ordinary arrangement of subscriber's circuit is shown, and it will be noted that the actuating coil a is bridged across the two sides of the line wire. The coil a, of course, is necessarily wound to about 500 ohms resistance to prevent short-circuiting the voice current. Two sleeves or thimbles, kk^1, are shown on each jack of the line, the inner ones k of which are shown permanently connected together and grounded through a battery k^3. The outer thimbles k^1 are connected together, and are usually connected to the ground directly through the restoring coil d. When with this arrangement a plug is inserted the two thimbles of the jack kk^1 are short-circuited by the sleeve on the plug, and the circuit through the actuating coil is thus closed on the battery k^3. This pulls the armature e back until it engages the catch c^4, and thus allows the shutter to swing into its normal position. Any subsequent currents coming over the line wire will fail to operate the drop, for the coil d will not allow its armature e to fall against the shutter g while the plug is in the jack of that line. This arrangement has been found to be subject to one very considerable objection, viz., the severe use of the battery k^3, owing to the fact that it is on closed circuit through the low resistance coil d as long as the plug is in its socket. In order to overcome this objection the plan shown in Fig. 4 was devised by Scribner. The wire leading from the thimble k^1 to the restoring coil is run to the pivot of the shutter g, as is shown, and the side of the restoring coil which is not grounded is run to the armature e. This connection is very clearly shown in Fig. 4. The shutter g is normally insulated from the armature e by virtue of the small hard rubber bushing e^5 and the insulation f^1 between the bracket f and the magnet d. When, however, the armature e falls forward, a small lug or platinum contact point j on the upper side of the armature strikes against and makes contact with the armature g, thus closing the circuit between them. If no plug is inserted into the jack of the line, the local circuit through the battery k^3 will be open at the jack, and the armature will be allowed to fall forward when released by the catch c^4. As soon, however, as a plug is inserted the local circuit through the battery will be completed, it being closed both at the armature contact point j and at the jack. This will send an impulse of current through the restoring coil, and pull the armature back until caught by the catch c^4. This same movement of the armature opens the circuit at the contact j, and thus no battery power is wasted. A subsequent calling signal upon the line circuit while the plug is in the jack will tend to operate the annunciator, but almost as soon as the shutter e is released the local circuit will be closed at the contact point j, thereby reattracting the armature to its normal con-

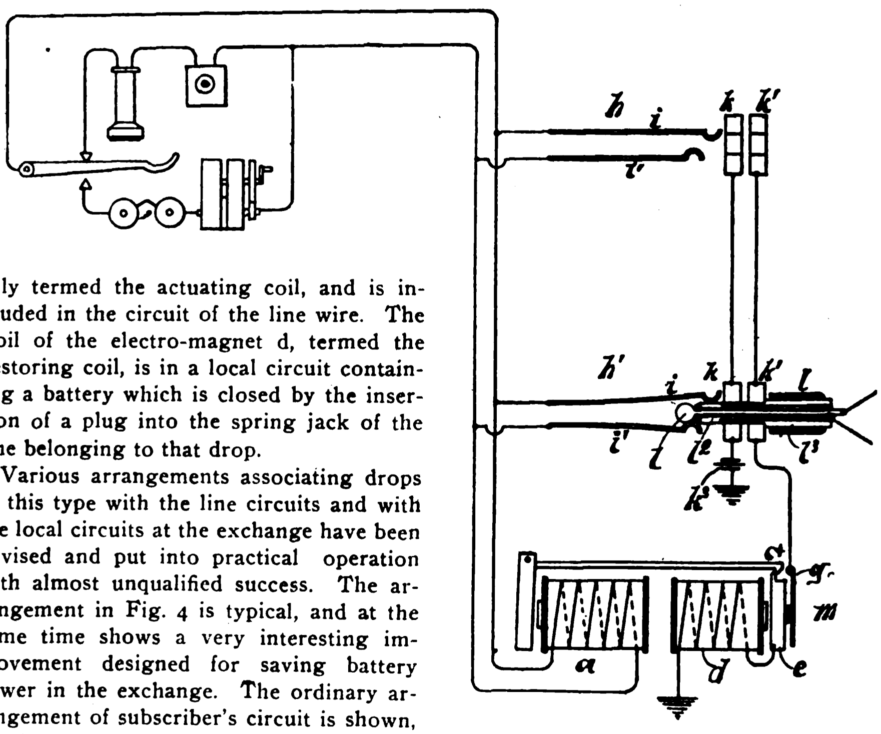


FIG. 4.—SCRIBNER SWITCHBOARD DROP.

dition and preventing it from falling to actuate the shutter.

An entirely different form of self-restoring drop has come into very general use among the companies operating in the United States in opposition to the American Bell Telephone Company. These are what are termed mechanically self-restoring drops, and two forms of them will be described.

LESSONS IN PRACTICAL ELECTRICITY

PHASING TRANSFORMERS

As the subject of phasing transformers involves the consideration of component forces and phase angles, a few introductory paragraphs will be devoted to the consideration of the parallelogram of force.

Suppose (Fig. 1) that a boat is rowed across a river at the rate of four miles per hour, the current of the stream being three miles per hour. If there were no current the boat would go straight across, following the line AB; if, on the other hand, the boat were permitted to drift along the shore, it would follow the line BC, drifting three miles. If, however, the boat is headed directly across the stream, the effect of both the effort in rowing and the current will cause it to have a course represented by the line AC, and in the same time that it would have been rowed four miles or would have drifted three miles, it will have proceeded five miles, landing at the point C. In other words, both forces will act precisely as if they were acting singly, but giving a resultant which in the above case is represented by AC, the component forces being AB and BC.

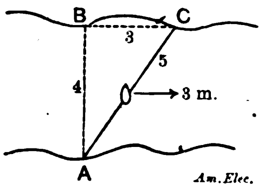


FIG. 1.—TWO FORCES AND RESULTANT.

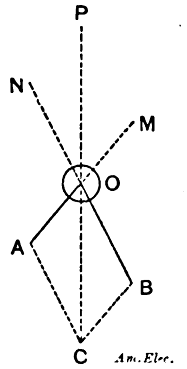


FIG. 2.—PARALLELOGRAM OF FORCE.

Now, referring to Fig 2, suppose that two forces represented in direction and length by AO, BO, are applied to move, for example, a barrel across a floor. Drawing CB parallel to AO and CA parallel to BO, we have a parallelogram, the diagonal of which, CO, will represent in length and direction the resultant of the two forces AO and BO; that is, acting alone, the force AO in a given time would cause the barrel to move through OM; similarly the force BO would cause the barrel to move in the same time through the distance ON, and the resultant or CO cause it to move through the distance OP.

The reason for this construction may be seen by reference to Fig. 3. As in the case of Fig. 1, the force BO may be considered to consist of two components at right angles, BS and SO; similarly, the force AO may be considered to consist of two components, AL and LO. Now, since CO is the diagonal of the parallelogram, a reader versed in geometry will see that AL is equal to BS; he will also see that these two components act in opposite directions, and therefore nullify each other. Consequently, the components free to act are represented by OS and OL; and CO being the diagonal of the parallelogram, LO is equal to CS, and OC is the sum of the forces free to act, or the resultant.

Suppose we have (Fig. 4) two e.m.fs. differing by quarter of a phase, or 90 deg.; one of these, AO, having a value of 86 volts, and the other, OB, a value of 50 volts. Squaring these values, adding and extracting the square root, gives 100 for the value of the hypotheneuse, AB, of the right angle triangle, ABO. That is to say, if we have a transformer whose secondary, bb, gives a voltage of 86, and another transformer whose secondary, aa, gives a voltage of 50, the current in one transformer differing in phase by 90 deg. from that of the other; then if one terminal of one transformer is connected to a terminal of the other, and a circuit led from the two other terminals, we will have a polyphase system consisting of the three circuits, aa, bb, cc, in which the voltages are 50, 86 and 100, respectively. In this case the angle ABO is equal to 60 deg., and the angle OAB is equal to 30 deg. As has been explained before, where we use a triangle such as the above, the differences in phase between the circuits will be represented by the supplement of the angles of the triangle, or 180 deg. minus the latter; therefore the phase differences between the above circuits will be 90 deg., 120 deg. and 150 deg. This, therefore, represents an unsymmetrical polyphased system, and would therefore not be used in practice.

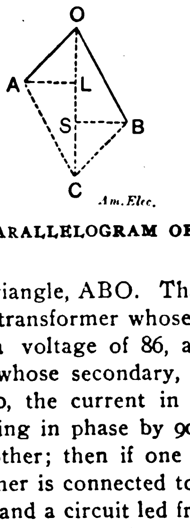


FIG. 3.—PARALLELOGRAM OF FORCE.

Now, taking up phasing transformers, suppose that in Fig. 5 BC refers to a secondary of a transformer having between its terminals an e.m.f. of 500; and AO to the secondary of another transformer having between its terminals an e.m.f. of 1000; furthermore, suppose that the current flowing in one transformer differs in phase by 90 deg. from the current flowing in the other. Now, suppose that one terminal of the secondary of the transformer AO is connected to the middle of the secondary of the terminal BC; then it will be seen from Fig 4 that between the points A and B, and also A and C, the e.m.f. will be 1000 volts. As we have assumed that the difference between the terminals of the transformer, BC, is 1000 volts, if, therefore, from the terminals A, B and C conductors are led, the difference of potential between any two of these conductors will be 1000 volts; moreover, in the triangle ABC, since the three sides are equal, the three including angles are also equal, and the value of each is 60 deg., since the sum of the three angles of a triangle is 180 deg. Consequently, the supplement of the angle in each case will be 120 deg., and we will have a symmetrical three-phase system. As practically applied, the primary terminals of the two-phase transformers BC and AO would be supplied from a two-phase machine at equal voltage, and the unequal voltage of 1000 and 860 would be obtained through one of the secondaries having a less number of turns than the other. It may be added that usually the two transformers are combined in a single structure.

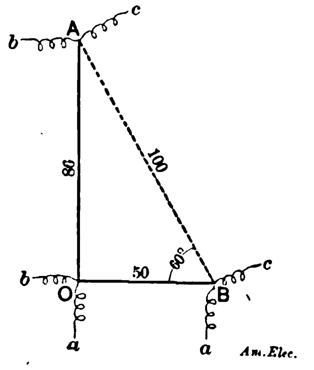


FIG. 4.—DIAGRAM OF PHASING TRANSFORMER.

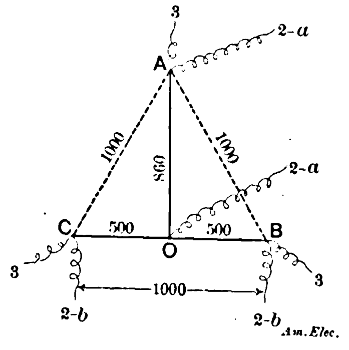


FIG. 5.—TWO-PHASE THREE-PHASE TRANSFORMER.

Fig. 5, it will be seen, represents a method of obtaining three-phased from two-phased currents. Such a phasing transformer is generally located at the generating end of the line, giving three-phased currents for transmission. At the receiving end of the line a similar transformer is located to change the three-phased into two-phased currents, should it be thought desirable to distribute according to the two-phased system.

Fig. 6 is a diagrammatical arrangement of the second transformer, which, it will be seen, is in all respects the same as the one at the generating end. In this case the three-phased lines are connected with the primary of the transformer, which will give a voltage of 860 in the section AO and 1000 in each of the sections AC, CB and BA, the section AO being connected to the middle of the section BC. As it would be desired to have the same voltage on the two two-phased lines, and not 860 volts on one and 1000 volts on the other, the two-phased secondaries will have an unequal number of turns.

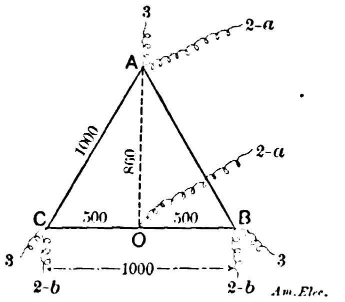


FIG. 6.—THREE-PHASE TWO-PHASE TRANSFORMER.

It will thus be seen that while the functions of the two transformers are different, their windings will be precisely the same if the receiving voltage is to be the same as the generating voltage. If, however, these two voltages are to differ, this is provided for by a change in the number of transformer turns, but with their proportions and connections remaining precisely the same.

In an article on another page by Prof. McKissick, other diagrams of phasing transformers are given, and also directions for the construction of one.

Letters on Practical Subjects

Telephone Induction Coils.

To the Editor of American Electrician:

It might be interesting to some of your readers to know, especially those who have had something to say on telephone induction coil resistance, that the coils used by the largest telephone company in the country measure about .4 ohm for the primary, and 19.5 ohms for the secondary of one style, and 14.5 ohms for another style. The secondary resistance is very low in comparison with those used in early days, but the coils referred to seem to work as well on a long line as on a short one. C. HOLMES.

New York.

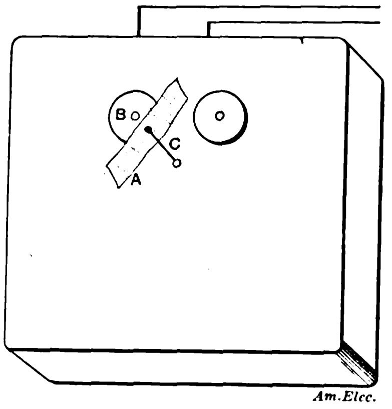
A Simple Telephone Annunciator.

To the Editor of American Electrician:

Following is a simple way of telling if there has been a call on the telephone while one is out, which takes the place of an annunciator and costs nothing to put in place:

A small piece of writing paper, A, is placed between the hammer of the magneto and a gong B. The hammer will hold the paper against the bell until there is a call, when it will drop out. On some 'phones the hammer does not touch a gong when at rest, but on nearly all it is in contact or nearly so. JAMES L. BROWN.

The Dalles, Ore.



A SIMPLE TELEPHONE ANNUNCIATOR.

Compounding and Equalizing Curves.

To the Editor of American Electrician:

Some time ago I noted a request in these columns for compounding curves, and send herewith a set of compounding test curves taken from three direct-connected dynamos. Following are the data of the machines as specified:

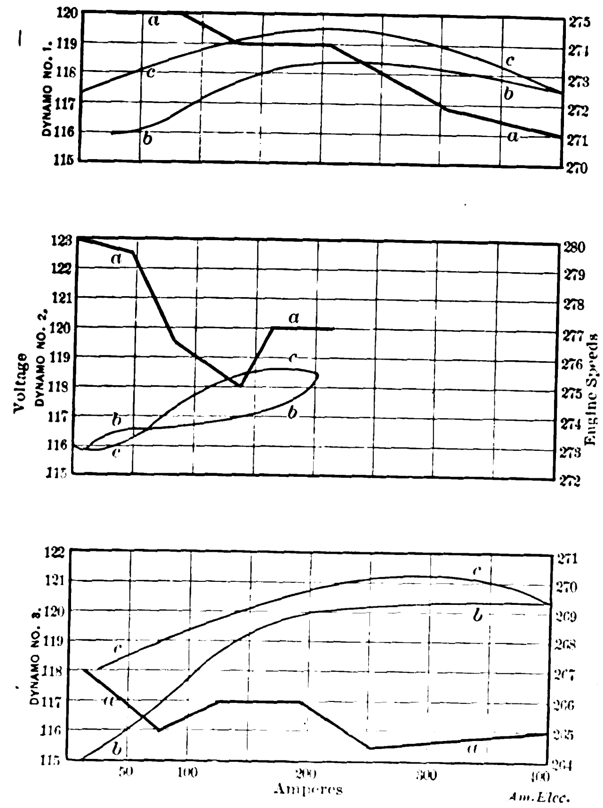


FIG. 1.—COMPOUNDING CURVES.

No. 1.	Speed 265 r. p. m.	Capacity 50 KW
No. 2.	" 275 "	" 25 KW
No. 3.	" 265 "	" 50 KW

As will be seen, the curves were plotted **under commercial conditions and not with reference to constant speed. An approximate curve for constant speed may, however, be simply determined from the data of the given curves.**

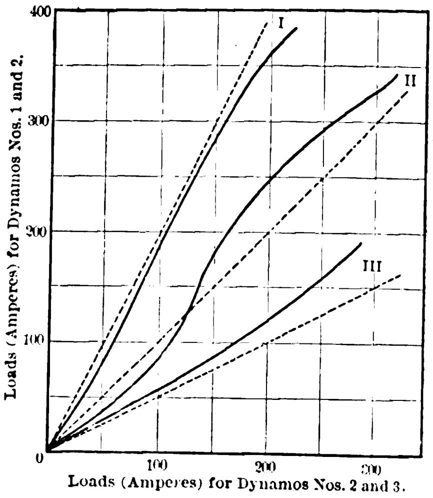


FIG. 2.—EQUALIZING CURVES.

The same dynamos were tested for equalization, and the results are plotted in Fig. 2.

The dotted lines represent the currents which would be given by the machines if run singly. The irregular curves were plotted from the readings of ammeters, one of which was placed in the circuit of each machine. M. N. BORDEN.

New York.

Water Rheostat for Controlling a Lathe.

To the Editor of American Electrician:

The foreman of a street car repair shop, having occasion to set up a motor for running an iron cutting lathe, found that the rheostat furnished with the motor was only wound for 110 volts, and that he was unable to keep the speed of lathe within limits therewith. To overcome the difficulty, an oil barrel was set up convenient to the motor, and two pieces of brass steam pipe, 1½ in., were placed in the barrel and kept apart by slipping them through holes bored in two bits of board. The boards were cut to fit across the inside of the barrel, and were nailed fast after they were in place with the pipes in them.

The pipes were connected up to the motor wiring, and placed in series with the starting rheostat and the lathe. When all was ready, the barrel was filled with water, and the resistance was found to be so great that no appreciable current passed through. A little acid stirred into the water soon cured this, and the solution was "tuned up" until the resistance was just great enough to balance the heavy voltage of a railway current.

The same appliance is a very handy thing to have when a few arc lights are needed

about a power house, to be run from the 500-volt circuit. Even for permanent circuits of ten arcs in series, a water rheostat, with the plates adjustable as to distance apart by the action of a solenoid in the circuit, would appear to make a good automatic regulator, and it will take care of a less number of lamps when one or two of the series are cut out by turning the switch in the "jumper" by which each lamp is arranged to be short-circuited at will.

Philadelphia, Pa. J. R. PERKINS.

Some Electrical Sport.

To the Editor of American Electrician:

It seems to be the proper thing now-a-days to keep some "Electrical Sport" agoing, and I will try my hand at that business for a change. But first I want to tell how a carpenter furnished electrical sport without meaning to do so. It was soon after the Pulitzer Building, in New York City, had been completed. It was desired to cut a door through one of the partitions between two of the offices, and a carpenter was at work at the job.

While engaged in stripping out the terra-cotta bricks, of which the partition was composed, he came across the three heavy insulated wires which composed the electric light distribution to that group of offices. The carpenter poked the three wires out of his way several times, but they kept falling back again. Finally the man got mad, gathered up the three wires in his left hand, and struck them with his hatchet. I was watching the man as he stood there on the staging, 5 ft. from the ground, and when he struck at the wires, I yelled at him, and started toward him, but was too late.

He struck another blow, and that time he hit the wires fair—all three of them. There was a flash and a bang up there by the carpenter, and another fireworks display in the corridor at the fuse box. The wires came off and down upon the floor, and most of the carpenter came with them, but his mustache, eye-brows and a good bit of his hair did not come with him. They went off into space, with a good chunk out of the edge of his hatchet and the fuse in the corridor. It is safe to say that the carpenter will never again try wire cutting with a hatchet when the "juice" is on. As for the sport it was sport for the observers, if not for the carpenter.

JAMES FRANCIS.

Brooklyn, N. Y.

ELECTRICAL CATECHISM

220. What is meant by $\mathfrak{B}$ and $\mathfrak{H}$ as applied to magnetism?

$\mathfrak{B}$ means the intensity of magnetization through iron or other magnetic substance. $\mathfrak{H}$ refers to the magnetizing force, or what is equal, the strength of the magnetic field when there is no iron present. For example, suppose that a wooden ring 10 ins. in diameter is wound with 1000 turns of wire through which a current of 10 amps. is sent. The strength of the magnetic field inside the ring equals 1.25 times the number of turns of wire times the amperes of current in the wire, divided by the length of the ring, measured in centimeters, or

$$\frac{1.25 \times 1000 \times 10}{10 \times 3.14 \times 2.54} = 156 \text{ lines per square centimeter.}$$

If the wire had been wound around a ring of wrought iron, the same magnetizing force would have caused a stronger magnetization of about 14,200 lines per square centimeter, or 93,000 lines per square inch. This would be called $\mathfrak{B}$.

221. How can one calculate the number of turns of wire necessary to magnetize a circuit?

There are a number of methods, all based on the law that the magnetization equals the magnetizing force divided by the reluctance of the magnetic circuit. A convenient method is given in the paper on "Designing Dynamos and Motors," in "American Electrician," February, 1898, page 59.

222. Is it necessary to have iron in a magnetic circuit?

Not always. In some cases it is better to have none, as in the case of certain instruments for measuring alternating currents, such as the Siemens electrodynamometer, the Weston A. C. voltmeter or the Thomson recording wattmeter.

223. What is there in common between measuring instruments and electric motors?

Nearly every instrument for measuring current, pressure or energy is really a motor in which the armature can rotate through only part of a revolution. A brief discussion of certain instruments may therefore properly introduce the study of the motor.

224. What is the electrodynamometer?

It is an instrument for measuring amperes, volts or watts. The Siemens electrodynamometer consists of two coils at right angles to each other, one coil being stationary while the other is free to rotate. Fig. 1 shows a common form, in which the stationary coil is inside, the movable coil being in the form of a rectangle outside the other and hung from a thread inside the spiral spring. Electrical connection with the movable coil is made through mercury cups into which the ends of the coil dip. When currents are sent through the two coils the magnetic stresses tend to move the two coils so as to become parallel, and the movable coil then begins to rotate to a position at right angles to that shown in the figure. The movable coil is then brought back to its original position by rotating the torsion head to which one end of the spring is attached. The amount of twist given the spring by the torsion head in order to bring the coil back to zero is a measure of the current in the two coils.

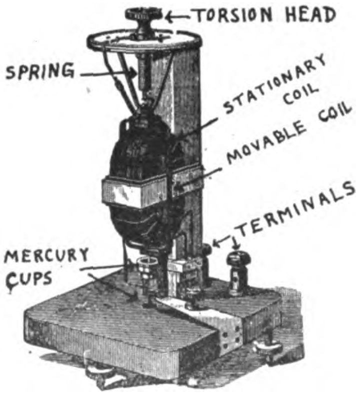


FIG. 1.—SIEMENS' ELECTRODYNAMOMETER.

225. How can the electrodynamometer be used as a voltmeter?

By having both coils made of a large number of turns of fine wire the instrument is sensitive to small currents. Then by connecting a high resistance in series with the instrument it may be connected across the terminals of the circuit whose pressure is to be measured. The electrodynamometer really measures the current passing through it, but by Ohm's law this is proportional to the pressure or e.m.f. at its terminals, and the force is therefore a measure of the e.m.f.

226. How can the electrodynamometer be used for measuring watts?

The magnetic force of each coil is proportional to the current through it, and the force tending to rotate the movable coil equals the product of the magnetic forces of the two coils. If, therefore, one coil is suitable for carrying the main current, and the other consists of many turns of fine wire with high resistance suitable for connecting across the circuit, the force between the two coils will be proportional to the product of current by volts, and therefore measures the watts.

227. What are the advantages of the electrodynamometer?

It is suitable for measuring currents either direct or alternating, and its calibration is independent of the frequency or form of the alternating current. Having no iron or permanent magnets, its reliability and permanency depend upon the spring, which experience shows does not change from year to year.

228. What are its disadvantages?

The instrument must be kept carefully leveled, and must be kept free from outside magnetic influences. It is not direct reading, but the torsion head must be adjusted so that the pointer comes back to zero each time before a reading can be made. It therefore requires some time and careful handling, and is of little use when the current fluctuates rapidly.

229. Are there other instruments based on the electrodynamic effect of the current?

Besides the Siemens electrodynamometer, there are other forms by Kohlrausch, Weber, Thomson and others, which are also zero instruments that must be adjusted for each reading. Some others, such as the Weston alternating current voltmeter, are direct reading, the coils being so shaped that the movable coil can rotate through a wide angle while a pointer attached to it travels across a scale and shows the voltage or e.m.f. at the terminals of the instrument. In the Bristol recording voltmeter the two coils are parallel and repel one another, the movable coil carrying a pointer that moves across a scale.

QUERIES AND ANSWERS

Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied. The privilege of this department only extends to subscribers, and queries must be accompanied by name and address to secure attention.

I have an alternating current lamp, the carbons of which jump violently up and down when current is turned on. What is the remedy? L. D. S.

A dash pot added will prevent the action described.

Is a storage battery injured by intermittent charging, as from a dynamo run by a windmill?—W. W. G.

No. But a dynamo may be designed to give practically a constant charging voltage over a wide range of speed.

Why is it that the induction coil used in the Bell system is composed of two separate primaries and secondaries? J. R. M.

Most probably only for convenience, since in special work it is sometimes desirable to split one coil or the other.

Can current from a 110-volt circuit be used for sparking a gas engine? C. D. A.

Yes; for the battery substitute a connection with the circuit, having in series a lamp, or two or more lamps in series-parallel.

Knowing the circular units, how may the diameter of a wire be determined? C. H. K.

Extract the square root of the circular mils, which will give the diameter in mils; dividing this by 1000 will give the diameter in decimal of an inch.

I have a synchronous motor in circuit with some induction motors. How shall I proceed with the former to reduce the power factor to unity? E. T. B.

Experiment by increasing the strength of the field of the synchronous motor. Motors are usually carefully designed for this purpose.

I want to design a condenser of 80 microfarads capacity for a voltage of 100. Kindly give the surface required, dielectric, size of box, etc. C. E. V. W.

Such a condenser would require not less than 2800 sheets of tin foil 1 ft. square, the sheets being separated by two layers of paraffined paper. We doubt if a single condenser of this size has ever been made.

What changes should be made in the windings of a transformer to change the voltage of the secondary a definite amount? J. R. P.

To lower the secondary voltage, increase the primary turns in the ratio of the present to the required primary voltage; or decrease the secondary turns in the ratio of the required to the present secondary voltage.

Does Ohm's law apply fully to alternating currents? J. S.

Yes, but in applying it allowance must be made for the counter e.m.fs. introduced into an alternating current circuit by inductance and capacity, and the accompanying difference of phase between the current and e.m.f.

What is the power in each branch of a three-phase line? E. T. B.

Calculate it, if balanced, as if the branch were a simple alternating current circuit; that is, the power is the product of the voltage, current and the power factor. If unbalanced, the calculation of the power in any of the three circuits with reference to the current flowing would appear to be very complicated.

How can I reduce an alternating current of 100 volts to one of 50 volts and 4 amperes? R. L.

Wind No. 20 or larger wire about a core or cylindrical ring of soft iron wire 1 in. in diameter, the number of turns to be determined experimentally.

How are the joints of a lead-covered cable made? A. E. G.

The copper joint is made as usual and insulated; a lead sleeve is then slipped over the joint and its ends wiped.

I have an alternating current fan motor running on a circuit of 20 cycles, and wish to run it on a circuit of 60 cycles. What change is necessary? L. W.

To preserve the present efficiency, it will be necessary to rewind the machine. Otherwise a non-inductive resistance may be placed in circuit of a value sufficient to take up half the voltage; or a choking coil may be used, its size to be determined experimentally, owing to the shifting of phase.

We have a 50-h.p., 220-volt, shunt-wound motor, receiving current from a generator 2 miles distant, and, owing to high line resistance the machine does not give sufficient power. We have a small generator of same voltage within 600 ft. of the motor, and I should like to know if there would be any advantage to use it to separately excite the field. H. S. R.

Owing to the small fraction of energy taken by the field there would be no material advantage. Connect the small machine to the line.

What is the simplest way of counting the number of vibrations of an induction coil interrupter? A. S.

Connect a telephone across the primary break and ask a friend with a musical ear to fix the fundamental note; knowing this, the corresponding number of vibrations may be obtained by reference to any book on sound. Or the telephone may be connected over a few turns of the primary or secondary, which will reduce the noise in the telephone, but still give the pitch.

1. Does a change in the resistance of a secondary coil affect in any way the primary current? 2. Would not the energy expended by the primary be the same if the secondary coil and connections were removed?—S. S.

1. Yes, if the change in the secondary resistance reduces the secondary current. 2. No; the energy expended in the primary coil is the product of the volts, amperes and cosine of angle of lag, and both of the latter are dependent on the current in the secondary.

What is the effect of operating a transformer made for 1600 alternations on a circuit of the same voltage 7200 alternations? E. T. B.

Since the rate of cutting is reduced the number of lines must be increased, and therefore also the magnetizing current; the copper loss is thus greater, and also the iron loss, since the loss per alternation increases faster as the lines are increased than it decreases from less cuttings. The heating also increases, which lowers the capacity of the transformer.

How may the watts be calculated necessary to raise water a certain number of degrees in temperature? E. T. B.

A horse-power is 550 foot-pounds per second, and also 746 joules per second, or 746 watts; therefore, a watt is .737, and a kilowatt 737, foot-pounds per second. A heat unit is equivalent to 778 foot-pounds; therefore, a kilowatt will raise a pound of water .94 deg. Fahr. in one second, or 56.4 degs. in one minute; or it will raise 18 lbs. of water from the freezing to the boiling point in one hour.

Has any economical method been devised for converting heat into electricity?—H. L.

No, and there is no probability of any such device equalling the efficiency of the steam engine and dynamo combined. As in the steam engine, only a part of the heat delivered is available for transformation, represented by the ratio of range of temperature to the upper temperature expressed on the absolute scale; besides, the intrinsic efficiency or percentage of available heat utilized is much smaller in thermo-electric devices than in the steam engine, and the same is true of the activity or capacity for a given weight.

Knowing the circular units of one size of wire in the B. & S. gage, how may the circular units of the other sizes be determined? C. H. K.

Three numbers are to be memorized. First, that the circular units of a No. 10 wire are 10,380; second, the factor .793, multiplying by which gives the next size below of any wire; and, third, the factor .629, multiplying by which gives the second size below. Furthermore, it should be remembered that in the B. & S. gage sizes are doubled every three numbers. For example, if we wish to know the circular mils of No. 3 wire, first find the circular mils of No. 12, which will be 10,380x.629=6590; therefore, No. 9 wire will have 13,180 c.m.; No. 6 wire, 26,360 c.m., and No. 3 wire, 52,720 c.m. The actual circular mils, according to a wire table, are 52,630.

Please give data for a dynamo to be used with a gas engine to furnish the spark. C. D. A.

Belt any small dynamo, such as a fan motor, to the engine; on the commutator place two rings, connected to diametrically opposite segments and insulated from all others. Lead the current from the rings to one winding on a core of soft iron wire, a second winding connecting with the spark gap. The number of turns in the primary winding will depend upon the voltage of the dynamo, and the number in the secondary on the sparking arrangement; if a "wiping" spark, the turns may be equal, and of, say, No. 22 wire; if a jumping spark, there will be needed many turns of fine wire on the secondary; or in this latter case an ordinary induction coil may be used with its primary connected to the machine and no rings employed.

NEW Apparatus AND Appliances.

WIRELESS TELEGRAPHY.

The central attraction of the late New York Electrical Exhibition was conceded by all to be the demonstration by Mr. W. J. Clarke, of wireless telegraphy, and through the courtesy of the manufacturers, the United States Electrical Supply Company, 120 Liberty Street, New York, we are enabled to illustrate herewith the apparatus used.

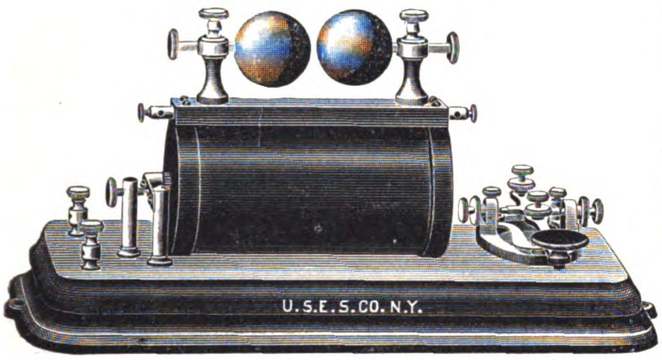


FIG. 1.—TRANSMITTER.

The form of transmitter is shown in Fig. 1. A storage battery feeds the primary of an induction coil. At tne exhibition the current from the battery first passed through an automatic circuit breaker, which made and broke the circuit in the same manner as a telegraph operator would when manipulating his Morse key in the act of calling "N. Y.," the telegraph call for New York City.

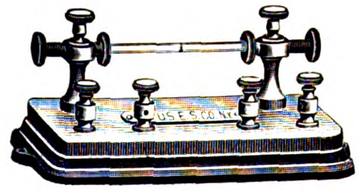


FIG. 3.—BRANLY TUBE.

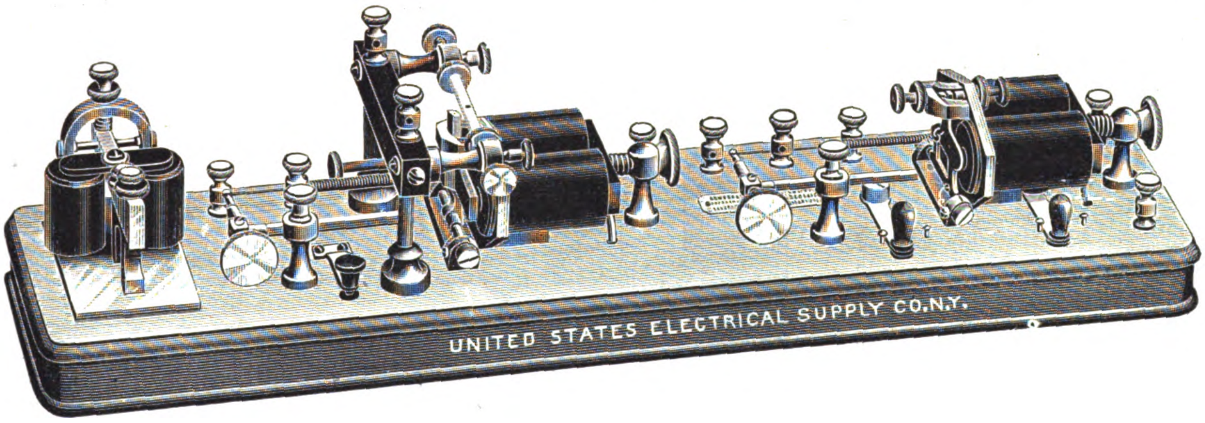

UNITED STATES ELECTRICAL SUPPLY CO.N.Y.

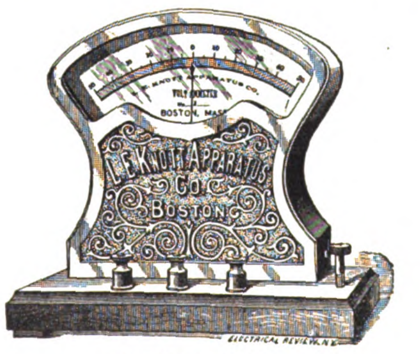
FIG. 2.—RECEIVER.

Over the induction coil is shown the Clarke oscillator, which consists of two solid brass balls about 4 ins. in diameter, mounted so that the distance between them is readily adjustable. The secondary terminals of the coil are connected to two binding posts on the heads of this oscillator. The distance between the balls being properly adjusted and the current turned on from the battery, the sound of the secondary sparks passing between the balls can quite easily be deciphered as the dots and dashes of the signal "N. Y." One terminal of the oscillator is connected to earth and the other to a brass rod about 10 ft. in length placed on top of the show case.

The receiver, Fig. 3, consists of a Branly-Clarke coherer relay and Clarke receiving instrument (the former shown separately in Fig. 3). At the exhibition a large 6-in. vibrating bell was connected up in the local circuit in addition to the telegraph sounder shown, and continually rang out the Morse signals "N. Y.," and by holding down the hammer of the bell the sounder could be distinctly heard repeating the same call.

LOW PRICED VOLT-AMMETER.

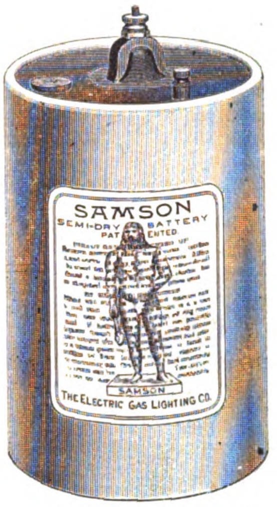
The increased use of storage batteries has created a demand for a practical low-priced volt-ammeter, and the cut here presented shows such an instrument devised with special reference to this work. It has a double winding with double graduations. As shown in the cut, one set of binding posts connect with the ampere coil and the other set with the volt coil. This instrument has an aluminum case, jewel bearings, and in every particular is claimed to be a substantial and practical instrument. The manufacturers are the L. E. Knott Apparatus Company, Boston, Mass.


VOLT AMMETER
L. E. KNOTT APPARATUS CO.
BOSTON, MASS.
L.E.KNOTT APPARATUS CO BOSTON
ELECTRICAL REVIEW, N.Y.

VOLT-AMMETER.

PORTABLE BATTERIES.

The accompanying illustration shows an open-circuit cell adapted for portable purposes where large current and long life are required. The elements are large and strong to enable the cell to perform the heavy work for which it is designed, and are contained in a porcelain jar 4⅝x7⅝ ins., which is sealed at the top to prevent the spilling of solution. The latter is made by filling the jar with water, which dissolves the dry salts placed therein.



PORTABLE BATTERY.

The makers state that this battery is used largely for gasoline launch work, portable gasoline agricultural machines, the operation of portable electrical devices, and for marine service. The cell is called the Samson semi-dry, and is claimed by its manufacturers, the Electric Gas Lighting Company, 193 Devonshire Street, Boston, Mass., to be much stronger and longer lived than their No. 2 Samson cell.

SKINNER AUTOMATIC SELF-OILING ENGINE.

The engine shown in the accompanying illustration is claimed by the makers to mark in several respects an important advance in steam engineering. One of the most important of these features is the self-oiling arrangement, which is shown in detail in the sketch.

Hinged to a stand bolted to the top of bed, is a feeder or oil tube overhanging the guides, and through sight-feed glasses placed therein oil is conveyed to the guides, cross-head and cross-head pin. To two stands placed near main bearings is hinged a feeder of arched shape, through which oil is conveyed to sight-feed glasses in the pillow blocks cap over shaft, and through which the main bearings and crank pin are oiled. Regulating screws are located in feeders over each glass, and when once adjusted require no further attention.

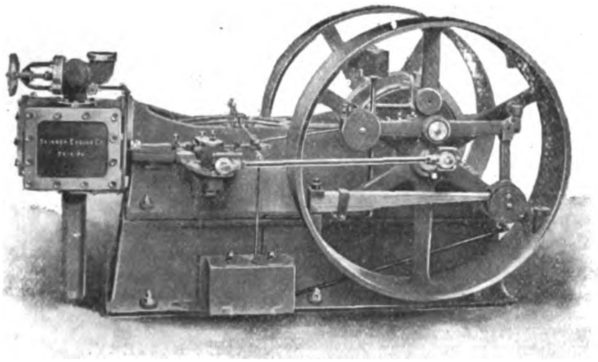


FIG. I.—SKINNER AUTOMATIC SELF-OILING ENGINE.

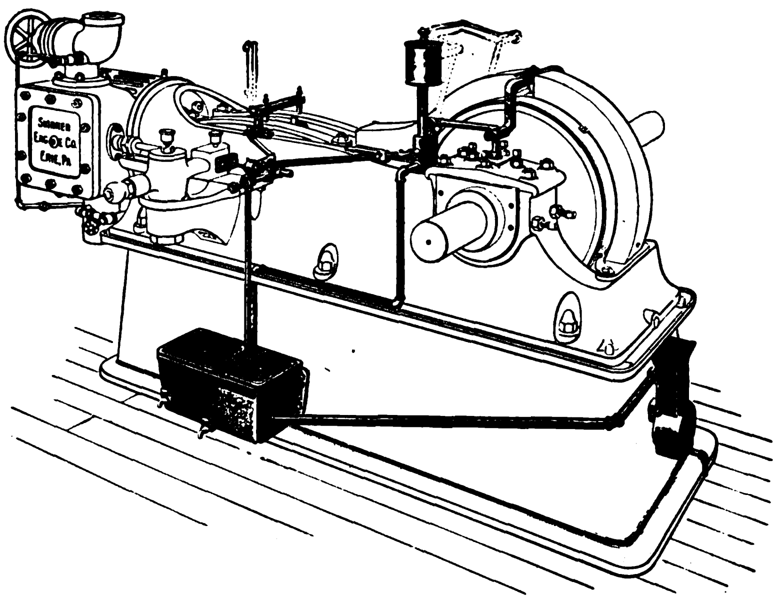


FIG. 2.—DETAILS OF SELF-OILING ARRANGEMENT.

When the engine is shut down, raising these jointed feeders to the position shown by dotted lines shuts off the oil supply, and when in this position ready access to any part of the engine for examination. adjustment or removal of any part, is afforded. By the loosening of a set-screw at each joint, each feeder and joint can be entirely removed from the engine.

A reservoir placed above the bed supplies the feeders with oil under a constant pressure, and is provided with an overflow which returns excess oil to the supply tank shown attached to side of sub-base. Oil is forced to the reservoir by a pump of peculiar construction operated from the valve slide. It has a positive motion valve and is noiseless. The valve and seat can be removed and replaced in position without stopping the engine or interrupting the flow of oil to the feeders; when removed oil is automatically shut off from the pump, and when replaced the pump immediately starts.

An oil and water separator is placed on the end of the sub-base below the engine, into which the drip (consisting of oil and the water from the stuffing boxes) flows, and in which separation of oil from the water is effected, the water escaping through a small pipe to the bottom of the separator, and the oil being drawn from a pipe at the top. This device, it is stated, has withstood the test of equal parts of oil and hot water combined by violent agitation, and passed through the separator at the full capacity of the funnel. There is an oil purifier in connection with the supply tank, into which oil flows from the separator and from which it passes to the supply tank freed from all foreign matter.

All parts of the system and the pipes connecting the different parts outside of the bed are in full view and reach of the attendant. Neither strainer nor filtering material (such as waste or sponge) is employed, nor anything that will obstruct free circulation of oil through the entire system.

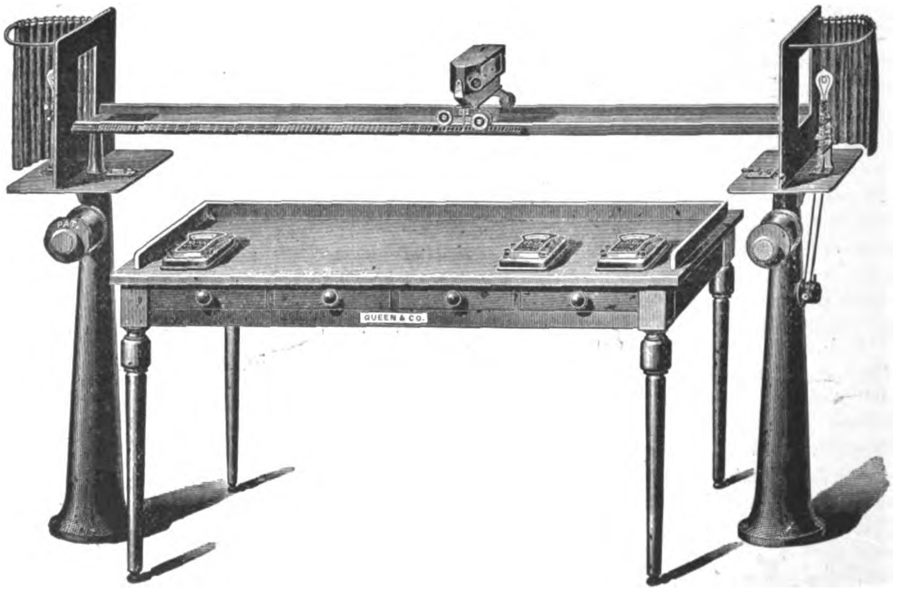
The valve is balanced and operated by a governor consisting of but three parts—eccentric arm, weight and spring, which are mounted in a wheel on frictionless roller bearing, requiring no lubrication.

The makers state that the governor will maintain the same regulation with steam pressure ranging from 30 to 100 lbs. The speed of engine can be changed 40 per cent by simply bolting on or taking off weights, and maintain the same regulation, without any other adjustment of the governor. The manufacturers guarantee that this governor will maintain a regulation within ½ of 1 per cent, and that the whole load may be thrown on and off the engine instantly, and the instantaneous change will not be over 1 per cent above or below, and will resume normal speed in six revolutions of the shaft.

The engine above described is made by the Skinner Engine Company, Erie, Pa.

NEW ELECTRIC LIGHT PHOTOMETER.

Queen & Company, Philadelphia, have placed on the market a new photometer, illustrated herewith. As will be noticed, it is a departure from the usual design. Cast iron pedestals support the metal photometer bar and carry stages for the support of the lights, screens, etc. The rheostat shown on the left hand pedestal is for the control of the potential on the standard, which is an incandescent lamp supplied with a certificate of standardization. It has about 800 or 1000 steps and permits of perfect adjustment. A similar rheostat on the right regulates the current on the test lamp. The graduated bar is inclined at an angle of 45 degs., in which position the graduations are lighted by the lamp under test.

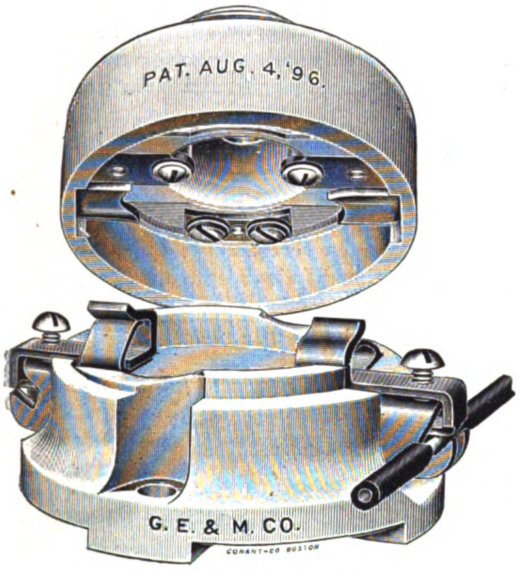


ELECTRIC LIGHT PHOTOMETER.

The screen, which may be of either the Bunsen or Lummer-Brodhun type, is mounted on a truck and may be rolled along the bar wherever desired. A milled head permits of close adjustment when balance is nearly attained. The instrument, it will be noted, is complete in every respect, and is the result of several years' experience with photometric apparatus.

CEILING ROSETTE.

The rosette shown herewith does not require the use of a screwdriver when it is to be re-fused, it only being required to give the cap a quarter turn. The line wire is held by clamps instead of screw points, thus not marring the softest wire. A long fuse may be used with this type of rosette, which is made by the Gilmore Electric Company, 625 First Street, South Boston, Mass.



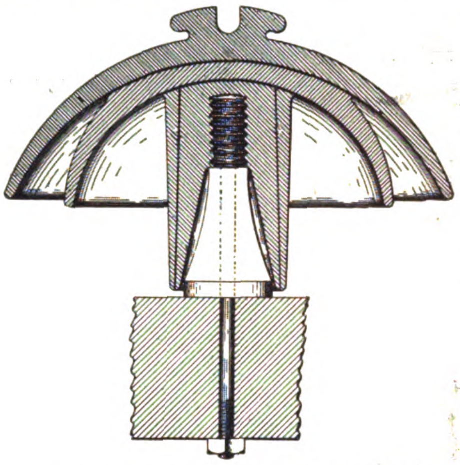
CEILING ROSETTE.

HIGH VOLTAGE LINE INSULATOR.

The accompanying engraving is reproduced from a patent granted June 7 of the present year to Fred. M. Locke, Victor, N.Y., and illustrates the principle of the insulator manufactured by the patentee for high voltage work.

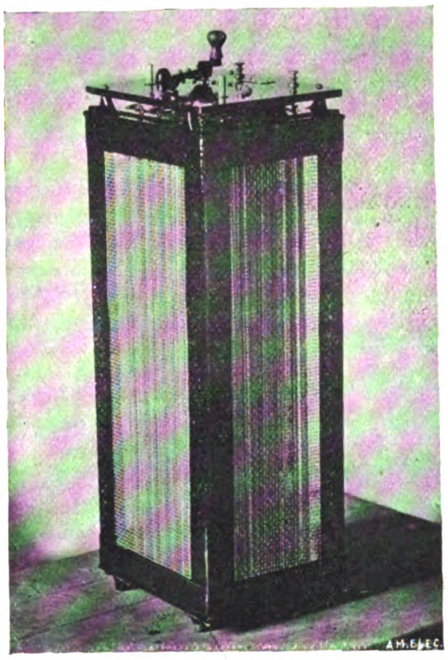
In the specification of the patent the inventor states that in passing a current of electricity of high voltage over a wire he has found that the static discharge from the surface of the insulator supporting the wire, or the arcing of the current around the insulator, burns the insulator pin off on a plane with the bottom of the petticoat extending the lowest. He has also found that by providing the insulator with a long central petticoat, which incloses the pin down to a point adjacent to the cross-arm, and by making it small in diameter in proportion to the adjacent petticoats of the insulator above it, this central piece is the most valuable insulating surface of the whole insulator on account of the fact that the area of the surface is so small that but little moisture at most can congregate there.

The object of the inventor therefore consists in so constructing an insulator as to prevent this leakage of the current over the insulator to the support, and thereby obviate the burning off of the pin, and to that end his invention consists in constructing an insulator having its inner petticoat extending down to a point adjacent to the cross-arms upon which the pin is mounted, to serve as a protecting sleeve for the pin and increase the arcing distance of the current around the insulator.



HIGH VOLTAGE LINE INSULATOR.

The insulator as shown consists of an outer shell, an inner shell and a central petticoat so elongated as to form a protecting sleeve for the insulating pin. This central piece may be constructed in two parts, as shown, and the pin itself be surrounded by a porcelain case, as also shown. The different parts of the insulator are secured together by coating them with a layer of glaze and then baking.



MOTOR SPEED REGULATOR.

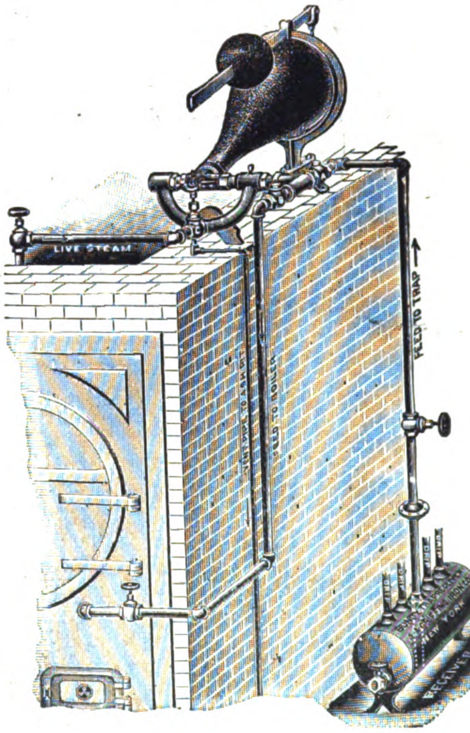
IMPERIAL MOTOR SPEED REGULATORS.

The accompanying cut represents a 5 h.p. Imperial motor speed regulator, manufactured by the Ohio Electric Specialty Manufacturing Company, of Troy, Ohio. This rheostat is built to stand a continuous flow of current supplying a motor under full load, and is used both as a motor-starter and speed-regulator. The regulator is fireproof and dissipates heat at a low temperature by providing for ample ventilation in all parts. Marbleized slate is used on the face of the regulator and the entire apparatus is neatly finished.

All contacts have ample capacity and close gradation of resistance between steps is given. These regulations are specially adapted for use with motors driving ventilating fans, pumps, manufacturing ice-cream, or any purpose for which regulation of motor speed is desired.

RETURN STEAM TRAP.

The economy of a steam trap that will return all drainage to the boiler is evident, and those who admire ingenious mechanism will find an additional interest in the steam trap illustrated herewith from the manner in which it enables this end to be attained.



RETURN STEAM TRAP.

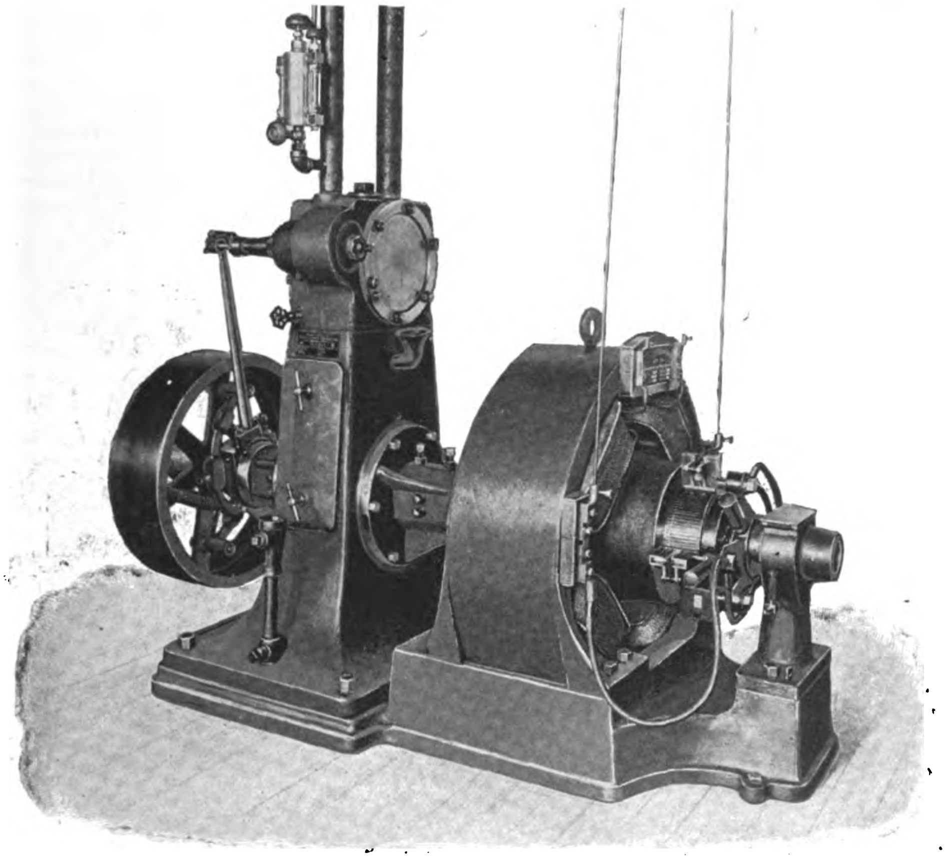
As shown the trap is fitted on a boiler to return condensation from radiators, coils, kettles or other appliances. The condensed water ascends the vertical pipe and passes through a check valve, A, into the pear-shaped bowl, the latter being kept open to the atmosphere through an air vent below, C, the pipe from which is shown leading to the ash pit.

When the bowl becomes nearly full the weight of water overbalances the weight of the ball shown, and the bowl tips toward the right. This motion raises the disc of a valve, C, which allows steam from the boiler to enter the bowl, the check, A, being closed by the consequent pressure. The pressure in the trap being now equal to the boiler pressure, the water contained in the bowl flows through a check, B, into the boiler. When the trap is emptied the ball weight raises the bowl, the valve, C, is thereby closed, the air valve under C opened, and the water of condensation again flows into the trap through A, the check, B, being closed by the boiler pressure.

The steam trap described, known as the Bundy return steam trap, is made by the A. A. Griffiing Iron Company, Jersey City, N. J.

A YACHT LIGHTING PLANT.

The electric lighting outfit shown herewith has recently been installed on the yacht "Ballymea," and consists of a Case engine and a Riker dynamo.



YACHT LIGHTING PLANT.

The dynamo is of cast steel with toothed armature, the armature core being keyed to a spider secured to the shaft. The construction of this spider facilitates radiation and insures a cool running armature and machine. Form wound armature coils are used, giving an electrically and mechanically balanced armature. The commutator bars are of tempered copper, and the insulation of the commutator and also of the armature is of mica. The field coils are wound upon thimbles with brass ends, and are insulated with mica.

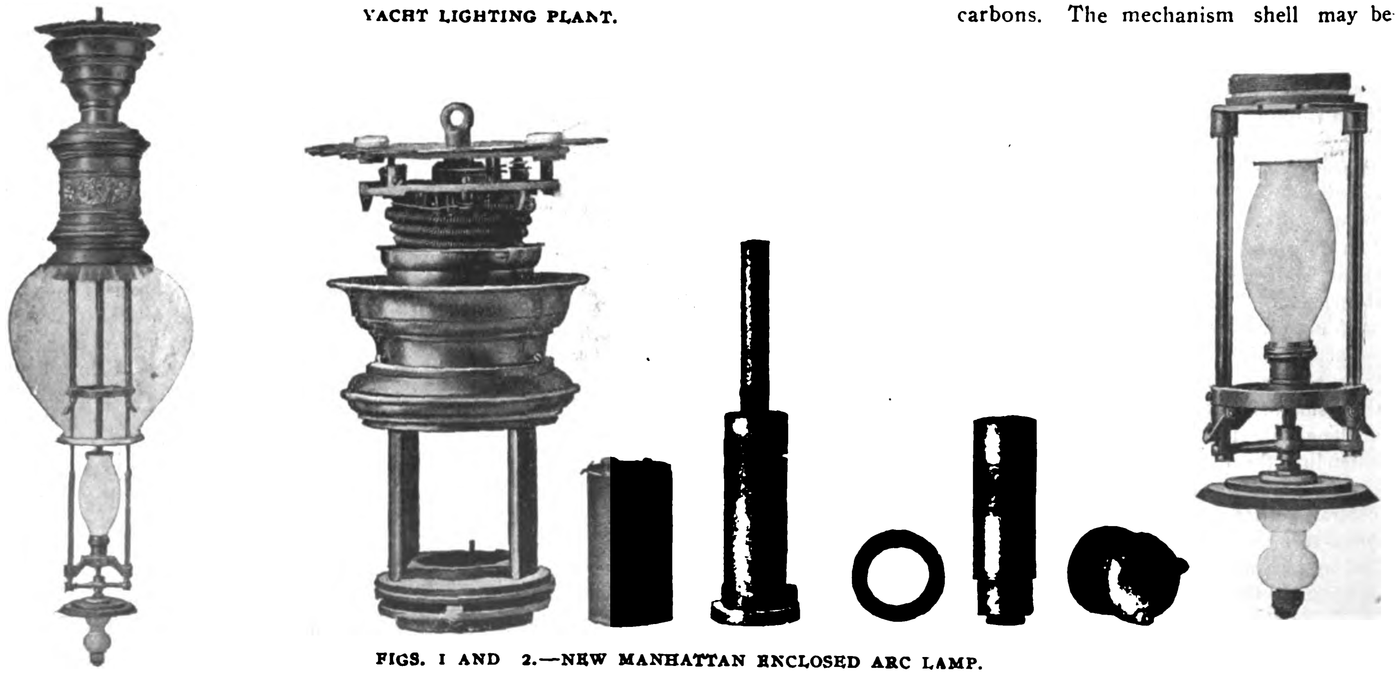
The brushes, which are of carbon, are held in position by a brush holder, which feeds the brush automatically and always in the same line. The machine is so designed that the brushes do not require shifting from no load to full load. The bearings are fitted with phosphor bronze bushings and oil rings. The latter dip into an oil well in each bearing pedestal and efficiently lubricate the shaft. All the moving parts are low and perfectly balanced, thus avoiding vibration. The Riker Company has also used the Case engine with the crank shaft extended on both sides of the machine and armatures on either end, the unit being used on three-wire circuits. The Case engine mentioned above is manufactured by the New Britain Machine Co., New Britain, Conn.

NEW MANHATTAN ENCLOSED ARC LAMP.

The new style of Manhattan arc lamp illustrated herewith is designed to burn in multiple on direct-current circuits of from 90 to 250 volts, in series on circuits of from 200 to 600 volts, and on alternating-current circuits of any frequency and from 90 to 130 volts.

In this new type the length has been decreased from 36 ins. to 29 ins., and numerous improvements have been introduced. In retrimming it is no longer necessary to remove several parts which have to be held in the hand, and the bulb is lowered down through the bottom of the water globe on double tube coping rods, as shown in Fig. 1, the inner bulb and carbon thus being brought into full view below the lamp. To lower the trimming device it is only necessary to press the knob on the bottom of the lamp. The current is fed to the upper electric carbon directly through the sheath, thus obviating the use of a separate brush box as formerly; contact between the sheath and the inner tube is made through metal balls, which are magnetically attracted against the sides of the inner tube, thus insuring good contact.

A new cap is used with the present lamp which materially lengthens the life of the carbons. The mechanism shell may be lowered while the lamp hangs in position by a very simple manual operation, thus



FIGS. 1 AND 2.—NEW MANHATTAN ENCLOSED ARC LAMP.

enabling the current adjustment to be changed at will. The adjustment of the rheostat for voltage may be made by loosening set screws and lowering the split canopy at the top.

The number of parts has been considerably reduced, all mechanism below the armature being dispensed with, and the only moving part in the lamp is the armature. The clutch consists of four balls which ride between the inclined surface of the inside of the armature and openings in the central brass tube. The armature and clutch may be removed from the lamp while it hangs in position by unscrewing one nut.

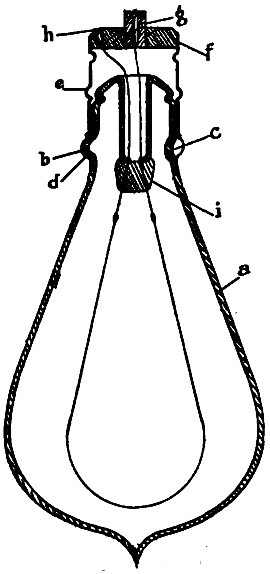
The controlling magnet is ventilated, thus providing against a burn-out under abnormal conditions that would cause trouble with the old form of magnet. A current of air is also kept constantly passing between the magnet and central tube.

The steady burning of the old lamp depended absolutely upon perfection of the air chamber, which caused variation in burning of different lamps, and it was impossible to make lamps altogether interchangeable. In the new lamp there is no such chamber, and a loose fit is maintained between all of the parts. In addition to the air chamber in which the armature works in the old lamp a further chamber was provided around the clutch, making it necessary to take the shell off in a most inconvenient manner, and great care had to be used in replacing insulation at this point, which made the old lamp most difficult to assemble. This has also been remedied in the new lamp. Instead of requiring a driving fit, all of the parts are now loose fits, and may be removed with the fingers, and the number of operations to assemble the lamp have been reduced from twenty to six. The various parts of the lamp are shown in Fig. 2. The manufacturers are the Manhattan General Construction Co., 11 Broadway, New York.

A NEW INCANDESCENT LAMP.

An incandescent lamp made with a base that does away with the use of plaster of paris, and which is interchangeable, is an innovation in lamp manufacture recently put on the market. Referring to the accompanying illustration, it will be seen that the bulb has on its upper portion an annular projection, b, containing a notch, c. Around this projection slips a split brass collar, d, which has an indentation to fit the projection, b, and also a small projection which fits in the notch, c, and prevents the collar from turning. Around this collar, which has an outward springing tendency, is slipped the base e, which may be of any one of the standard styles. The upper portion of this base is closed by a porcelain disc, f, with a brass tip, g, in the center, to which one of the terminals is soldered, the other terminal being soldered to the base, e, at h. The leading-in wires are fused into a glass projection, i, in the usual manner. A drop of solder mechanically joins the collar, d, with the base, e, and prevents the latter from turning.

This method, as will be seen, does away with the use of plaster of paris, making a mechanically strong lamp and one that will not soak up or hold moisture which, by electrolytic action, eats away the inleading wires and short circuits the lamp in the base. These lamps have interchangeable bases and are especially adapted to street lighting, sign work, for use in damp places and in places where lamps are roughly handled. The above lamp, which is known as the "20th Century" lamp, is manufactured at the Twentieth Century Lamp Works, 1031 Walnut Street, Philadelphia.



A NEW INCANDESCENT LAMP.

NEW BOOKS.

ANDERSON'S PHYSICAL EDUCATION. By William Gilbert Anderson, M. D., New York: A. D. Dana. 102 pages, illustrated. Price, 50 cents.

This pamphlet is a treatise on physical training by means of special apparatus for use in the house, the writer being Professor of Gymnastics in Yale. The movements for exercising different portions of the body are described in detail, numerous illustrations making their learning an easy matter.

APPLIED MECHANICS. A Treatise for the Use of Students Who Have Time to Work Experimental, Numerical and Graphical Exercises, Illustrating the Subject. By John Perry. 678 pages, 371 illustrations. Price, $2.50.

As a thorough practical treatise on applied mechanics from the standpoint of the engineer, this book can be recommended without reservation. One of its valuable characteristics is the manner in which the student is taken into the confidence of the author, being everywhere guided by helpful advice, and having pointed out to him the practical limitations and bearings of the knowledge imparted. The numerous examples all relate to calculations met with in practical work, and principles are illustrated by reference to actual machines and practice. The work is therefore of special value to the engineer, both as a book of reference and as a means of finding out the real significance of the knowledge he previously obtained as a student from the usual school text-book on mechanics.

THE ARITHMETIC OF THE STEAM ENGINE. By E. Sherman Gould. New York: D. Van Nostrand Company. 104 pages, 6 illustrations. Price, $1.

The object of this volume is to impart a knowledge of the fundamental principles of the steam engine, and to illustrate practical calculations based upon them. The examples are on the calculation of heat, engine efficiency, horse power, etc. Tables are given of hyperbolic logarithms and of the properties of saturated steam. A useful feature is a list of standard books on steam and mechanical engineering.

THE LOCAL DISTRIBUTION OF POWER IN WORK SHOPS, ETC. By Ernest Kilburn Scott, A. I. E. E. London: Biggs & Company. 148 pages, 23 illustrations. Price, 2s.

Much tabulated matter of value is contained in this volume on the subject of interior power distribution, including data on the power required for driving various kinds of machines. Part I. takes up the subject of the advantages of electric driving, and the power required by various machines. Part II. is on the advantages and disadvantages of alternating current from the standpoint of power distribution. Part III. consists of notes on the various points of a power installation, with examples of recent practice.

THE PRINCIPLES OF ALTERNATING CURRENT WORKING. By Alfred Hay, B. Sc. London: Biggs & Company. 289 pages, 119 illustrations. Price, 5s.

The outcome of a course of lectures originally delivered to a class of evening students, this book presupposes on the part of the reader but little electrical or mathematical knowledge. The author being apparently a teacher, he naturally drops into academic methods, summing up, for example, in definitions which are of no earthly use if the reader has understood the preceding explanations. Nevertheless, the book is perhaps the most satisfactory simple exposition of alternating current phenomena yet written in English.

FIRST PRINCIPLES OF ELECTRICITY AND MAGNETISM, By C. H. W. Biggs. London: Biggs & Company. 497 pages, 343 illustrations. Price, 3s. 6d.

This book, about half of the contents of which appeared originally in the columns of our English contemporary, *Electrical Engineer*, is written for beginners in practical electrical work, and as an easily read treatise, it will be found useful in obtaining an elementary knowledge of the fundamental principles of electrical science. It has an advantage over the usual book having a similar object in that its information has, as far as possible, a direct practical bearing. Text-book methods are avoided, and weight is given to subjects in accordance, not with their theoretical interest, but with the importance they assume in practical work.

TRADE PUBLICATIONS.

ELECTRICAL ROCK DRILLS. — The Marvin Electric Drill Company, Canastota, N. Y., have published a 32-page pamphlet, describing and illustrating the Marvin electric percussion drill, many forms of which are shown in half-tone engravings.

SWITCHES, PANEL BOARDS, Etc.—J. Jones & Son, 64 Cortlandt Street, New York, in their catalogue No. 6, illustrate numerous forms of switchboards, panel boards and panel board boxes, knife switches of all types and capacities, and a full line of switchboard fittings.

WIRT DYNAMO BRUSHES AND RHEOSTATS.—With this title, Charles Wirt, 1028 Filbert Street, Philadelphia, has issued a catalogue of Wirt dynamo brushes, rheostats and Queen-Wirt electrical measuring instruments. Several pages on the use of brushes will be of interest to dynamo tenders.

SWITCHBOARDS AND SWITCHES.—The Technic Electrical Works, 214 New Street, Philadelphia, Pa., have issued a pocket price list of isolated plant switchboards and knife switchboards. Panels of from one to six circuits are listed, and switches of from 100 to 500 amps., both single and double pole.

TRANSFORMERS.—The Lakon Company, Elkhart, Ind., has issued a unique publication, in which a tale of a dog that grins introduces us gradually to the subject of transformers in general, and the Lakon transformer in particular. The story of the dog is carried on in illustrations after it has been dropped in words.

INSULATION MANUAL.—The Mica Insulator Company, New York and Chicago, has issued an "Electricians' Sheet Insulation Manual," in which the various forms of insulation made by it are described, a sample of the insulation being secured to the page facing the description.

PRISMATIC ELECTRIC SIGNS. — The Prismatic Electric Sign Company, Williamsport, Pa., in a well printed pamphlet describes and illustrates types of prismatic signs which, by means of electric illumination, can be made to produce the most brilliant effects.

LINE AND CONSTRUCTION TOOLS.—The Western Electric Co., of Chicago, in a 24-page pamphlet, gives a complete list of construction and linemen's tools, including illustrations of all the more important or latest types of such tools. This pamphlet is known as "Tool Catalogue No. 3," and may be obtained upon application.

STEAM SPECIALTIES.—The 1898 catalogue of the Lunkenheimer Company, Cincinnati, Ohio, is handsomely bound and contains 208 pages of matter, and perhaps twice that number of cuts. Each type of steam fitting is clearly described, and where desirable, directions for setting up and use are given.

TUBULAR BOILERS.—The Murray Iron Works Company, Burlington, Iowa, in a catalogue of high pressure tubular boilers, prints some extremely fine half-tone illustrations of boilers which, we learn from the imprint, come from the engraving department of our contemporary, the "American Machinist."

PELTON WATER WHEEL.—A new edition, recently issued, of the catalogue of the Pelton Water Wheel Company, San Francisco, Cal., includes a vast amount of data referring to the utilization of high heads of water. An interesting feature consists of concise descriptions of electric light and power plants employing the Pelton wheel.

IRON-ARMORED CONDUITS.—The Safety Conduit Company, Rankin Station, Pa., has issued a pamphlet devoted to the "Loricated" electric conduit for interior construction. This conduit consists of a smooth tube of mild iron or steel, having a tough insulating coating that will not crack or come off in bending, and will resist acids and alkalies.

GASOLINE ENGINES.—The Otto Gas Engine Works, Thirty-third and Walnut Streets, Philadelphia, have issued a large-page catalogue, with illuminated cover, in which the Otto gasoline engine is thoroughly described and illustrated. Among the applications illustrated are for driving dynamoes, horseless vehicles, marine purposes, &c.

BRISTOL RECORDING INSTRUMENTS.—The Bristol Company, Waterbury, Conn., has issued a "partial" list of recording instruments for pressure, temperature and electricity, which nevertheless includes 117 different varieties and ranges. More than half the list is devoted to recording voltmeters, ammeters and wattmeters, for both direct and alternating currents.

TELEPHONES.—The ninth edition of the catalogue of DeVeau & Co., 27 Rose Street, New York, contains several novelties. Among these is an "egg" telephone for suspending from a wall, ceiling or bracket. When not in use the transmitter and receiver fit together, and have somewhat the appearance of a suspended egg. This is claimed to be the smallest telephone outfit on the market.

OILS AND BOILER COMPOUNDS.—In a neat pamphlet with a cover of unique design the Dearborn Drug and Chemical Works, 29 Rialto Building, Chicago, gives some advice on the selection of oils for different work which the engineer will find of value. Another pamphlet, uniform with the above, treats of boiler compounds in a similar manner.

INCLOSED ARC LAMPS.—The Jandus Electric Company, Cleveland, Ohio, in a pamphlet handsomely bound and printed, besides giving descriptions of the Jandus arc lamp, includes some curves, accompanied by explanatory matter, showing the distribution of light from this type of lamp. Those interested in either inclosed arc lamps or fine printing will find much to please them in this pamphlet.

HUNT RAILWAYS.—Two recent publications of the C. W. Hunt Company, 45 Broadway, New York, are entitled "Hunt Automatic Railway" and "Hunt Cable Railway." The former railway is for transferring coal from the wharf to the bin, and is operated entirely by gravity. The cable railway is for handling coal and merchandise under all conditions. Both pamphlets are handsomely gotten up and profusely illustrated.

STURTEVANT ENGINES.—In a well-printed and handsomely illustrated and bound catalogue of 48 pages, the B. F. Sturtevant Company, Boston, Mass., shows an exclusive line of engines for electric light plants and general high-grade work, and a number of Sturtevant direct-connected electrical generating sets. The latter are of both the inclosed and open type, the latter following the latest marine engineering practice.

MACHINE TOOL MOTORS.—The Bullock Electric Manufacturing Company, Cincinnati, O., is sending out a neat card showing on one side a Bullock motor, direct connected to a 72-in. Gray planer, the other side containing a concise statement of the advantages of electric motors for machine tool driving, neatly printed in two colors. The card forms an attractive and effective educational inclosure for letters.

WALKER BULLETINS.—Walker bulletins 1072-1078 are devoted to static transformers; Walker car motors for street lines, elevated or suburban traffic; railway switchboards, the Walker underground conduit; switchboards for lighting plants, and the Walker pivotal trolley, with Grover trolley head. The bulletin on the Walker underground conduit gives an excellent idea of the system now being so extensively applied in New York City.

ELECTRIC LIGHT SUPPLIES.—A cloth-bound volume of 555 pages, just issued by the Western Electric Company, covers, to quote from the preface, "only such material as is specially adapted to electric light works." As the type is smaller than any used in this journal, the vast development in electric lighting is significantly illustrated by this remark. The volume contains more than 2000 illustrations, and each article listed is accompanied by a telegraphic code word.

LIGHT VS. ILLUMINATION. — Under this title the Holophane Glass Company, 1 Broadway, New York, has issued a 64-page pamphlet on light and illumination, with particular reference to the holophane system of globes, invented by Prof. Blondel, professor in the Ecole des Ponts et Chaussees, Paris. This pamphlet takes rank as a technical treatise on the subject of illumination, and will be found interesting reading by all central station men.

ELECTRIC HEATERS.—The American Electrical Heater Company, 197 River street, Detroit, Mich., has just issued a new catalogue of electrical heating devices, and among the features we note the very attractive trade mark which this company has adopted. Among the devices recently placed upon the market by this concern is a new electric curling iron heater in the form of a column which, being heavily nickeled and mounted on a marblized base, presents a very handsome appearance. The many other new features described make the catalogue a valuable one.

HOW CAN I BECOME AN ELECTRICAL ENGINEER?—With this title the Electrical Engineer Institute of Correspondence Instruction, 120 Liberty Street, New York, has issued a well-printed pamphlet of 64 pages, illustrated with more than thirty half-tone portraits of the great masters of electrical science, from Gilbert to Steinmetz, and of great electrical inventors, from Morse to those of the present day. The text points out the superior advantages of the electrical engineering profession, and how one may become proficient in it.

CROCKER - WHEELER BULLETINS.—Bulletins 1-5 of the Crocker-Wheeler Company have the following subjects: Bulletin 1, bulletins, figures, photographs and patents; bulletin 2, fans; bulletin 3, dynamotors and motor-dynamos; bulletin 4, motors and dynamos; bulletin 5, small size of very slow motors for direct attachment to machinery. The last three bulletins aggregate 106 large pages, and form a technical treatise on the subjects considered, two bearing the signature of Dr. O. O. Wheeler and the third that of Gano S. Dunn, electrical engineer of the company.

LIGHTNING ARRESTERS.—The General Electric Press, Schenectady, sends forth another extremely artistic specimen of the printer's art in a 32-page pamphlet on lightning arresters, the cover and title page of which are beautiful in design. The introduction is a short examination of the qualifications necessary to a perfect lightning arrester, with a short disquisition on the special advantages of the magnetic blow-out. This is followed by concise descriptions of the various types of General Electric arc and incandescent station arresters, including the more recently developed lightning arrester for direct current circuits up to 850 volts, and the short-gap arrester, especially designed for alternating current circuits.

BUSINESS NEWS.

THE WALKER COMPANY, Cleveland, Ohio, is now supplying the Brooklyn Elevated Railway with 400 motors of 80-h.p. each, and is making a specialty of large motors for heavy interurban traffic.

SWITCH PATENT.—In the suit of the Perkins Electric Switch Mfg. Company vs. the Gibbs Elec. Mfg. Company, before Justice Townsend, the Gibbs patents were sustained and the bill against them was dismissed.

THE WESTERN ELECTRIC COMPANY, Chicago, desires to advise the central stations using alternating current apparatus that it will be pleased to quote prices on the Lakon transformers and Lakon cut-outs for transformers.

THE WARREN-MEDBERY COMPANY, of Sandy Hill, N. Y., is now manufacturing a full line of Medbery switches and switchboards in all their various styles, and will shortly be able to supply the market with its widely known Medbery insulation.

DR. F. A. C. PERRINE has obtained two years' leave of absence from Leland Stanford, Jr., University in order to accept during that time the position of consulting electrical engineer for a company which will transmit electric power from Blue Lakes City to San Francisco.

THE CENTRAL TELEPHONE & ELECTRIC COMPANY, of St. Louis, which succeeded to the D. A. Kusel Telephone Manufacturing Company and the Missouri Telephone Manufacturing Company, reports that it has doubled its business in the last six months, and is now about to increase its plant and secure larger quarters.

JAGABI PORTABLE TESTING SET.—James G. Biddle, 910 Drexel Building, Philadelphia, has recently filled an order for ten Jagabi testing sets for the United States Government. A pamphlet description of this very efficient testing outfit has recently been issued, a copy of which may be obtained by application to the above address.

THE JANDUS INCLOSED ARC LAMP manufactured by the Jandus Electric Co., Cleveland, Ohio, has found warm friends in central station men. Economical in current consumption, noiseless in operation, steady in burning and furnishing an ideal illumination, it succeeds in winning business from people who before had declined to use the electric light.

THE CENTRAL ELECTRIC COMPANY, Chicago, reports a brisk trade on the Westinghouse alternating current fan motors, of which it is carrying large quantities in stock. The company also reports a number of new specialties in its house goods department, prominent among which is a new and simple device for electrically lighting the incandescent gas or Welsbach burner.

ELECTRIC SMELTING.—The Burton Electric Smelting Company, 144 Lincoln Street, Boston, Mass., has issued a 32-page pamphlet, giving a full exposition of the Burton processes of electric liquid metal smelting, of heating and working metals by electricity and electrical amalgamation. The several processes are described in detail, and numerous cuts show the various applications.

THE TWENTIETH CENTURY LAMP WORKS of Philadelphia have acquired the rights to manufacture lamps under the Fowler patents. A special feature of this type of lamp is its interchangeable base, no plaster of paris being used—an undoubted advantage to supply houses in renewing their stock. These lamps are equipped with a cellulose filament, and are claimed to be electrically unsurpassed.

PROF. J. J. FLATHER has been appointed Professor of Electrical Engineering in the University of Minnesota. Prof. Flather for the past seven years has been Professor of Mechanical Engineering at Purdue University, Lafayette, Ind., where he built up one of the best courses in mechanical engineering in the country, being particularly strong along the lines of steam engineering and machine design.

THE ELECTRIC GAS LIGHTING COMPANY, of Boston, Mass., has recently built a 260 drop return-call annunciator of the Ross style, for the Indianapolis District Telegraph Company, to be installed in Hotel English, Indianapolis. This is one of a number of large instruments built by this company this spring for hotels in different parts of the country. The company states that its output of annunciators has been exceedingly large the past few months, necessitating running its factory nights to keep up with its orders.

THE SPRAGUE ELECTRIC COMPANY, at its works, New York City, 527 West Thirty-fourth Street, is running day and night upon contracts for interior conduit and Lundell power motors for the Government. The interior conduit manufactured by the Sprague Company is the standard of the United States Government, and it is used not only upon a large number of warships and cruisers, but upon many of the improvised cruisers recently called into service for scouts, torpedo boats and coast defense ships.

GAS ENGINES.—Among recent shipments of gasoline engines for electric lighting purposes made by the Frontier Iron Works, Detroit, Mich., are one 60-h.p. tandem to Sanborn, Ia.; one 50-h.p tandem for Silver City, Ia., and one 50-h.p. tandem for Norway, Mich. The company reports that this engine has shown remarkable results on electric lighting work, the regulation being practically as good as that of a steam engine, and they are now prepared to make all sizes, from 10 h.p. to 100 h.p.

AN IMPORTANT COMBINATION in the rheostat business has just been consummated by the consolidation of the Cutler-Hammer Mfg. Company of Chicago, and the American Rheostat Company of Milwaukee. The business will be carried on under the name of the Cutler-Hammer Mfg. Company, at 70-80 West Jackson Street, Chicago. The capital stock of the combined company has been increased to $75,000, and a large proportion of this increase has been invested in new machinery. The officers of the new company are as follows: F. R. Bacon, president; F. L. Pierce, vice-president; J. G. Hickcox, secretary and treasurer; H. H. Cutler, electrical engineer and general manager.

PIONEER LAMPS.—Kaufman Brothers, of Pittsburg, Pa., have placed an order for over 400 Pioneer inclosed arcs for their new building with the Electric Arc Light Company, 120 Liberty Street, New York. A unique feature of this installation will be the complete lighting of the store with arcs and gas chandeliers. This is the first store in the country to be entirely equipped in this manner. The Pioneer lamp was selected after a three months' competitive test with other makes of inclosed lamps on the market.

THE GOUBERT MANUFACTURING COMPANY, New York, has secured from the Metropolitan Street Railway Company of that city the contract for feed-water heaters for the mammoth power station being erected at Ninety-sixth Street and East River. The first installment consists of 30,000 h.p. in six heaters, horizontal type, and rated at 5000 h.p each. They are to be placed between the low pressure cylinders and the condensers. It is said to be the largest single order for feed-water heaters ever placed in this or any other country.

THE JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J., has secured the following flattering testimonial of the merit of their graphite from an official of the Pennsylvania Railroad Co.: "I had a gas engine at Sharon, Pa., running a pump, and the man that had charge of it allowed the lubricator to run dry and cut the piston, piston rings and cylinder. I had some of Dixon's finely pulverized graphite, and I commenced to feed it into the cylinder through the suction pipe with the air and gas, with immediate relief. After about two weeks the engine was running smoother and using less gas than ever before."

LAMP SHADES AND HOLDERS AND TUBE CLEANERS.—The Faries Mfg. Co., of Decatur, Ill., has recently established an office at 136 Liberty street, New York, under the management of Mr. A. W. Koenig, where a full line of Faries goods may be seen. Among these are a universal adjustable lamp holder, which is made in about thirty different designs of portable and stationary desk and table lamps, side wall fixtures, chandeliers, pendant hall lamps and dental lamps; aluminum and steel lamp shades and reflectors in three styles; fire and water tube boiler cleaners. A comprehensive catalogue may be obtained upon application.

THE OMAHA EXPOSITION OF 1898 surpasses in interest the Centennial Exposition which occurred in Philadelphia in 1876, and is next to the World's Fair at Chicago in importance to the whole country. All of the States in the Trans-Mississippi region are interested, and a visit to Omaha during a continuance of the Exposition, from June to October, inclusive, is recommended to all. Buy your excursion tickets over the Chicago, Milwaukee & St. Paul Railway. An illustrated folder, descriptive of the Exposition, will be sent you on receipt of two-cent stamp for postage. Address George H. Heafford, General Passenger Agent, Chicago, Ill.

A LARGE MILL ELECTRIC PLANT.—The Lyman Mills, which is the largest mill corporation of Holyoke, Mass., employing about 1500 hands, is a progressive concern, and their recent adoption of electric power for the operation of their machinery will undoubtedly have a marked influence upon many other firms in their vicinity. The Westinghouse Electric and Manufacturing Company has installed for the mills a 250-k.w., 440-volt, two-phase, 3600 alternating generator, direct connected to an Allis-Corliss engine running at 120 r.p.m. Six Westinghouse type "C" motors, varying in size from 30 to 75 h.p., are used for the operation of spinning frames, mules, looms, the machine shops, etc.

THE HAZELTON BOILER CO., New York, have orders from the following concerns: Goodyear's India Rubber Glove Manufacturing Co., Naugatuck, Conn., two boilers (third and fourth orders); the New York Mutual Gas Light Co., New York City, two boilers (eighth and ninth orders); the People's Gas Improvement Co., Trenton, N. J., two boilers; the South Middlesex Street Railway Co., South Framingham, Mass, one boiler (third order); A. H. & C. B. Alling, woolen manufacturers, Derby, Conn., one boiler; the Greenfields Electric Light and Power Co., Greenfield, Mass., one boiler (second order); the Brooklyn Union Gas Co., Brooklyn, N. Y., two boilers (eighth and ninth orders), and three boilers for M. Guggenheim's Sons, for their smelting works at Monterey, Mexico. Nearly all of the above boilers will be equipped with the very complete brick lined steel jacket, with square furnace and square grate surface, lately introduced to public use by the Hazelton Boiler Co.

TWO HANDSOME TRAINS—The two splendid trains known as the "Pioneer Limited," which the Barney & Smith Car Company of Dayton, Ohio, has constructed for the Chicago, Milwaukee & St. Paul Ry. Company are now in service between Chicago, Milwaukee, St. Paul and Minneapolis, and it is undoubtedly true that these trains are among the finest products of the car builder's art ever yet exhibited. These duplicate trains consist of the usual mail, express and baggage cars (the latter furnished with bicycle racks and carrying a Westinghouse engine and dynamo to furnish power for the electric lighting of the entire train), buffet, smoking and library cars, standard sleepers, compartment sleepers, dining cars, parlor cars, day coaches and reclining chair cars. The entrance to each car is by way of massive "flush" vestibules, finished in San Domingo mahogany, the elegance of which is but a taste of the splendid display within. All of the cars are electric lighted, steam heated, and the metal finishings are in handsome old bronze made to special design. The method of electric lighting is unique. For emergency, and in addition to the regular dynamo under each car, is located an auxiliary battery sufficient to light a dozen or more lamps in each car. The exterior of these trains is unusually beautiful, all of the cars being painted a deep rich yellow in different shades and finished in gold. The fastest and most powerful locomotives in America are used to haul these superb trains over the Chicago, Milwaukee & St. Paul Railroad, which owns one of the finest roadbeds in the world. . . .

ELECTRIC LIGHT CONVENTION NOTES.

MR. GEORGE CUTTER, of Chicago, interested many in the "Cutter Specialties."

MR. JOHN T. M'ROY, of New York, was present in the interest of the McRoy conduit.

MR. A. W. MORRELL spent a few hours at the convention in the interest of the Miller-Knoblock Company, of South Bend, Ind.

MR. CHARLES E. GREGORY was present, representing the Elliptical Carbon Company, of Chicago and Cleveland.

THE SAWYER-MAN ELECTRIC COMPANY, of Allegheny, Pa., was represented by Mr. Clarence A. Ross, its Western agent.

I-T-E CIRCUIT BREAKERS had their merits brought to the favorable attention of many of the delegates by Mr. H. B. Cutter.

MR. P. C. BURNS, president of the American Electric Telephone Company, was at the convention, where he was warmly greeted.

MESSRS. J. H. M'GILL AND J. G. POMEROY, of Pomeroy & McGill, Chicago, improved the opportunities presented by the convention.

MR. A. R. HUSSEY discussed with several members the advantages of the telephones manufactured by the Allen-Hussey Company, of Chicago.

MR. M. C. JOHNSON looked after the affairs of the Electrical Trading Company, Chicago, dealers in second-hand transformers, etc.

A. L. IDE & SON, Springfield, Ill., manufacturers of the well-known Ideal engine, had their interests well taken care of by their Chicago representative, Mr. Enos Bookwalter.

MR. HENRY SHAFER, of the Stromberg-Carlson Telephone Manufacturing Company, Chicago, was present at several sessions of the convention.

MR. W. E. DOOLITTLE, representing the Sterling Electric Company, of Chicago, made many friends at the convention.

THE CHICAGO INSULATED WIRE COMPANY, Chicago, was represented by Mr. W. M. Smith.

THE CHICAGO FUSE WIRE MANUFACTURING COMPANY, Chicago, sent as its representative Mr. W. R. Goodman.

THE GEORGE M. MAYER MODEL AND MACHINE WORKS, of Chicago, was represented by Mr. Mayer.

MR. T. S. LANE AND MR. R. RALPH LANE represented the Electrical Exchange of Chicago.

MR. W. P. SULLIVAN looked after the interests of the Menominee Electrical & Mechanical Company, of Menominee, Mich.

MR. PHILLIP CASS, of Cass & Aaron, Chicago, looked after the interests of his company at the convention in his usual energetic manner.

MR. JOHN VALENTINE, president of the Valentine-Clark Company, Chicago, dealers in poles, was present at the sessions of the convention.

THE CHARLES E. GREGORY COMPANY, Chicago, had its interests looked after by Messrs. A. Louis Kuehmsted and W. A. Raymond.

MR. A. C. GARRISON, president of the Columbia Incandescent Lamp Company, St. Louis, represented his company's interests at the convention.

MR. C. D. JENNEY was present in the interest of the Jenney Electric Manufacturing Company, Indianapolis, Ind., and was warmly welcomed by many of his old friends.

JAMES C. WORMLEY & CO., Chicago, exhibited a number of very neat designs of portable and bicycle electric lamps working from dry batteries.

THE FARR TELEPHONE AND CONSTRUCTION SUPPLY COMPANY, Chicago, had its interests looked after by Mr. C. W. Farr.

A. O. SCHOONMAKER, of New York, manufacturer of mica and mica products, was represented by Mr. John Child, who exhibited a magnificent sheet of transparent mica.

THE PHOENIX CARBON COMPANY, St. Louis, was ably represented by Col. H. C. Booker, whose genial presence always lends a feature of attractiveness to these gatherings.

MR. THOMAS FERRIS, the Wisconsin representative of the General Electric Company, was present at the convention, where, as usual, he made many friends and was much in demand.

AN INTERESTED ATTENDANT at the convention was Mr. Seiichi Hirota, the London representative of Takata & Company, of Tokio, who are among the largest dealers in electrical and steam machinery in Japan.

THE DODGE MANUFACTURING COMPANY, of Mishawauka, Ind., manufacturers of pulleys and power transmission machinery, was represented by Mr. H. E. Hurlburt, of its Chicago office.

THE LAKON COMPANY, of Elkhart, Ind., was represented by its president, Mr. John C. Boss, who reported a large and steady demand for the well-known transformers manufactured by his company.

THE GARTON-DANIELS ELECTRIC COMPANY, Keokuk, Ia., makers of the well-known lightning arrester bearing its name, was represented at the convention by Mr. W. R. Garton, of Chicago.

THE CABINET MANUFACTURING COMPANY, Steubenville, Ohio, which has recently been doing a great deal of work in the telephone line, was represented by Mr. J. W. Hull.

THE AMERICAN CIRCULAR LOOM COMPANY, Boston, Mass., distributed a highly appreciated souvenir in the shape of a box containing a pipe with tobacco and matches.

MR. W. B. HUGHES, of the Central Manufacturing Company, Chattanooga, Tenn., interested many of the delegates in the yellow pine cross arms, oak brackets and electrical mouldings manufactured by this company.

MR. H. E. PROCUNIER, the president of the Moon Manufacturing Company, Chicago, was frequently seen in the convention hall, and interested many in the annunciators manufactured by his company.

THE JANDUS ELECTRIC COMPANY, Cleveland, Ohio, may be sure that few of the delegates present failed to become acquainted with the merits of their well known line of inclosed arc lamps, which were ably explained by Mr. H. T. Edgar.

THE DEARBORN DRUG & CHEMICAL WORKS, of Chicago, manufacturers of boiler compounds, were ably represented by Mr. C. S. Kehler, who distributed a unique and amusing souvenir in the shape of a red, white and blue cap.

THE DIAMOND ELECTRIC COMPANY, of Peoria, Ill., interested many at the convention in their new alternating current integrating wattmeters, of which they had two on exhibition.

MESSRS. L. A. CHASE & COMPANY, of Boston, distributed some interesting circular matter illustrating and describing the Chase "Knock-out" outlet and junction boxes, as well as their other specialties.

MR. CONVERSE D. MARSH, president of the Bryan-Marsh Lamp Company, interested many delegates in the merits of their Imperial lamps. Mr. Marsh was ably supported by Messrs. S. Everrett Doane and Joseph M. Hill.

MESSRS. F. M. BACON AND J. GILBERT HICKOX, of Milwaukee, formerly of the American Rheostat Company, which has just been consolidated with the Cutler-Hammer Manufacturing Company, Chicago, were present.

MR. JOHN S. MAURER represented interests of the Crouse-Tremaine Carbon Company and the Fostoria Incandescent Lamp Company, Fostoria, Ohio. Mr. B. M. Myers, the Chicago representative of the latter company, was also present at the convention.

THE CENTRAL ELECTRIC COMPANY, of Chicago, was represented by its president, Mr. George A. McKinlock, and Messrs. Charles E. Brown, Charles G. Burton, W. P. Upham and C. W. Cobb, who presented many at the convention with a handsome souvenir consisting of an aluminum ash tray.

THE CRANE COMPANY, Chicago, manufacturers of steam fittings, was represented by its mechanical engineer, Col. G. A. Hurd, whose interests are now equally divided between steam supplies and a volunteer regiment of engineers, which he is raising in Chicago and its vicinity.

MR. F. C. ARMSTRONG, formerly of the Canadian Electric Company, and recently made the London representative of Dick, Kerr & Company, received congratulations from his many friends upon his appointment to the new position, which those who know him are confident that he will adorn.

MR. GEORGE F. PORTER, the genial secretary of the association, found time to attend not only to his manifold official duties, but also to put in a word in the interest of Kerite wires and cables. Mr. W. R. Brixey's interests were also looked after by Mr. E. L. Barr.

THE D. & W. FUSE COMPANY, Providence, R. I., had a number of its fuses mounted with switches, lightning arresters, etc., in the main parlor of the hotel. Their good points were ably presented to those interested by Mr. L. W. Downes and Mr. A. W. Hutchins.

MR. JAMES WOLF, better known to the trade as "Jimmy," represented the New York Insulated Wire Company, New York, and his well deserved popularity secured for him the enthusiastic reception which has greeted his appearance at so many conventions.

THE MANHATTAN GENERAL CONSTRUCTION COMPANY, of New York, had on exhibition two of its latest models of inclosed arc lamps. Mr. S. Marsh Young, vice-president and general manager of the company, explained to the delegates the features of his new lamps.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, was represented by its president, Mr. W. W. Lowe, and Secretary Thomas I. Stacey. The hustling abilities of these well-known gentlemen have won for their company an enviable position in the electrical field and a success of which they may well feel proud.

THE OKONITE COMPANY, of New York, was represented by Capt. W. L. Candee. Capt. Candee did not suffer interest in Okonite to flag during the days he spent in Chicago, and assisted the memories of a few lucky friends with a souvenir, consisting of a very beautiful porcelain miniature, handsomely framed.

MR. JAMES CUMMINGS represented the various interests in which he plays a prominent part, chief among them being the new Cummings Electric Tube Company, of Detroit, which manufactures an underground current of high tension. He also looked after the interests of the Cummings Conduit Company, of Detroit, and the Armorite Company, of Pittsburgh.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., had on exhibition a switchboard panel furnished with an illuminated dial voltmeter, ammeter and wattmeter with series transformers. Mr. H. A. Wagner, of course, attended the convention, representing the Missouri Edison Company. The Wagner Company's interests were looked after by Messrs. Abadie, Layman, Pillsbury and Johannesen.

MR. G. O. ROCKWOOD, of the Rockwood Manufacturing Company, Indianapolis, Ind., exhibited at the convention some interesting models of the well-known paper pulleys manufactured by his company, which is also engaged in making friction gears and polishing wheels. Mr. Rockwood has just returned one order for over 2000 pulleys.

EUGENE MUNSELL & CO. and the Mica Insulator Company, of New York and Chicago, were represented at the convention by Mr. Charles E. Coleman, their Western manager. The companies' blotters were distributed freely at the writing rooms and various headquarters of the different companies represented at the Auditorium during the convention.

MR. H. H. CUTLER, president of the Cutler-Hammer Rheostat Company, of Chicago, was present to keep up the interest in rheostats, motor controllers, starting switches, speed regulators and the other well-known auxiliaries manufactured by his company. Mr. Cutler said that his factory is working on full time, and that every indication points to a prosperous season.

THE SPRAGUE ELECTRIC COMPANY, New York, was represented by its president, Mr. E. H. Johnson, and Mr. C. A. Benton. Mr. Johnson is a familiar figure at electric light conventions, having been one of the early presidents of the association and a charter member. A number of fan motors exhibited by this company did excellent service in the corridors of the Auditorium.

THE WESTERN ELECTRIC COMPANY, Chicago and New York, exhibited a number of fan motors and "Sunbeam" incandescent and arc lamps. Mr. C. D. Crandall, manager of the Chicago office; Mr. A. L. Tucker, manager of the supply department; Col. George L. Beetle, Thomas J. Grier, L. K. Comstock, J. W. Ebert and Charles Wilkinson were in attendance.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, Pittsburgh, exhibited a number of high voltage and other types of Sawyer-Man lamps. The company was well represented by Messrs. F. H. Taylor, general sales manager; Maurice Coster, manager of the Chicago office; A. J. Wurts, A. S. Morris, H. A. Ebert, Henry Floy and a number of members of its Chicago force.

J. HOLT GATES & CO. were represented at the convention by J. Holt Gates, George B. Foster and C. H. Philbrook. This firm handles the apparatus of the Walker Company, of Cleveland, Ohio; of the Wagner Electrical Manufacturing Company, of St. Louis, Mo., and the Card Electrical Company, of Mansfield, Ohio. They report the sale last month of 1900 k.w. of generators, besides numerous switchboards, street railway equipment and other electrical details.

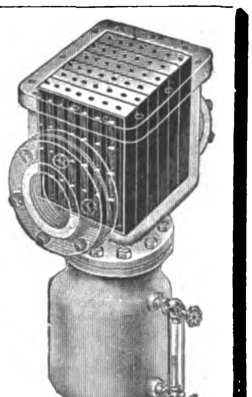
THE STERLING ARC LAMP COMPANY, New York, exhibited a number of its inclosed arc lamps under the supervision of Mr. R. J. Randolph, its general manager. These lamps, of a new and very simple design, were shown in operation and as adapted for constant potential and series systems, both direct current and alternating. To insure the remembrance of his visitors Mr. Randolph provided each of them with a combined pencil and cigar cutter, one of the neatest souvenirs given at the convention.

THE WALKER COMPANY, of Cleveland, Ohio, was represented at the convention by J. Holt Gates, George B. Foster, C. H. Philbrook and F. H. Talbot, of the Chicago office. Many of the delegates were interested in the new alternating system of the Walker Company, as well as its new Solenoid Blow-out Controller; also the "L" type of street railway motor of 150-h.p., twenty of which are being supplied the Metropolitan Elevated RR. of Chicago. Many of the visitors called at the new station of the Chicago City Railway, which is designed for fifteen 880 k.w. Walker rope driven generators.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, made no exhibit at the convention hall, but previous to the date of the meeting had extended an invitation to those attending to visit the station of the Chicago Edison Company and there inspect the large battery recently installed. Most of those in attendance accepted the invitation, and were repaid by the interesting sight of the operation of the largest storage battery in the world—22,400 amp. hours at normal discharge. The representatives of the company present were Messrs. Herbert Lloyd, general manager; J. Appleton, chief engineer, and F. J. Clark, of the Chicago office.

THE GENERAL ELECTRIC COMPANY did not make an exhibit, but took several parties of delegates to visit the various great stations in Chicago equipped with its apparatus. Through the courtesy of President Insull, of the Chicago Edison Company, and Mr. W. E. Baker, of the Metropolitan West Side Elevated Railroad Company, the stations of both these companies were thrown open to these parties, and much interest was manifested. Attention was particularly directed to the converter sub-station system which Mr. Insull has inaugurated in Chicago. The representatives of the company present comprised the entire selling staff at its Chicago office, and several representatives from the offices in other cities. Among them were Messrs. B. E. Sunny, F. H. Boyer, Theodore P. Bailey, J. Scribner, W. S. Arnold, W. J. Ferris, G. J. Caldwell, J. W. Buell, J. W. Johnson, R. C. Noe, O. E. Turner, A. J. Gifford, S. H. Atkin, H. T. Windsor, S. F. Dibble, W. H. Colman and J. J. O'Brien, of the Chicago office; P. A. Clisdell, of the Minneapolis office; George D. Rosenthal, of the St. Louis office; J. H. Livsey, of the Detroit office; W. F. Hays, W. J. Hanley and I. R. Prentiss, of the Cincinnati office; F. M. Kimball, of the Boston office; H. H. Crowel, of the Syracuse office; W. S. Andrews, of the Schenectady works; J. Dalzell, of the Lynn works; A. D. Page, of the Harrison works, and John McGhie, of the New York office.

THE FOLLOWING COMPANIES were also represented at the convention: Messrs. K. McLennan & Co., of Chicago; Cravath Manufacturing Company, Chicago, by J. R. Cravath; Washburn-Moen Manufacturing Company, Worcester, Mass., by Mr. Channing T. Gage, of the St. Paul office; New York & Ohio Company, Warren, Ohio, by Mr. W. D. Packard; Davis Electrical Works, Springfield, Mass., by Mr. Charles F. Munder; Indiana Rubber & Insulated Wire Company, Jonesboro, Ind., by Mr. R. E. Lucas; Munson Belting Company, Chicago, by Col. J. H. Shay; Simplex Electrical Company, Boston, Mass., by Mr. H. R. Hixson, of the Chicago office; Bradford Belting Company, Cincinnati, Ohio, by Mr. O. M. Hubbard; H. B. Camp Company, Aultman, Ohio, by Mr. A. L. Daniels; Zamel Arc Light Meter Company, of Chicago, by Messrs. A. G. Zamel and Charles C. Schumacher; Charles A. Schieren & Co., of New York; by Mr. A. W. Watriss; Warren Electric & Specialty Company, Warren, Ohio, by Messrs. W. S. Hull and E. W. Gillmer; Perkins Electric Switch Manufacturing Company, Hartford, Conn., by Messrs. C. G. Perkins and Edward K. Patton; Royal Electric Company, Peoria, Ill., by Mr. G. G. Luthy; American Battery Company, Chicago, by Mr. George T. Burroughs; India Rubber & Gutta Percha Insulating Company, New York, by Dr. William M. Habirshaw; Standard Underground Cable Company, Pittsburgh, Pa., by Mr. J. R. Wiley; American Electric Heating Corporation, Boston, by Mr. James I. Ayer; American Carbon Company, Noblesville, Ind., by Messrs. Edmund Dickey, A. T. Webb and A. J. Blum; Southwark Foundry & Machine Company, Philadelphia, by Mr. Edward M. Hagar, its Chicago representative; Bryant Electric Company, Bridgeport, Conn., by Mr. Edward R. Grier, its Western manager; Illinois Electric Company, of Chicago, by Mr. H. E. Adams; Phoenix Carbon Manufacturing Company, St. Louis,



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SAFETY WATER COLUMN.

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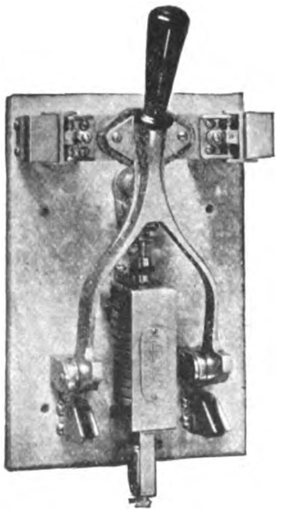
CIRCUIT . . BREAKER . INSURANCE

Can you afford to place your insurance in a company of which you know nothing, or in a company of which the little you know is not likely to increase your confidence? Buying a circuit breaker is like buying insurance. Fire Insurance is a needless expense if you are sure you will have no fire. It's the same with a circuit breaker, if you are sure you will have no grounds, no short circuits, no damage from your wires being struck by lightning, you don't need a circuit breaker. But you cannot be sure, therefore a circuit breaker is a necessity.

I-T-E CIRCUIT BREAKERS



Single Pole only for Alternating Current. Front or Back Connections 5 to 200 Amperes; 2000 Volts or less.

give you a feeling of confidence. They cost little and are absolutely reliable. They are in use in lighting and power stations all over the country. We will be glad to send you a catalogue and full information.

The CUTTER ELECTRICAL & MFG. CO.,
1112 Sansom St., Philadelphia, Pa.
120 Liberty Street, New York.

Mo., by Col. S. G. Booker; Smith-Hill Elevator Company, Quincy, Ill., by Messrs. C. G. Comstock, Thomas Holl and H. S. Wells; M. C. Bullock Manufacturing Company, Chicago, Ill., by Mr. John Svenson; Atlas Engine Works, Chicago, Ill., by Mr. A. M. Morse; T. H. Carbon Company, of Boston, Mass., by Mr. D. F. Urquhardt; Solar Carbon & Manufacturing Company, Pittsburgh, Pa., by Mr. H. E. Webb; Chicago Sectional Underground Electric Company, by C. H. Wilmerding; Stanley Electric Manufacturing Company, by Mr. William S. Hine; Chicago General Fixture Company, Chicago, Ill., by Mr. W. F. Hold; Standard Paint Company, by Mr. J. C. Shainwald; Washington Carbon Company, Pittsburgh, Pa., by Mr. J. S. Crider; J. M. Atkinson & Company, Chicago, Ill., by Mr. J. M. Atkinson; Leschen - Macomber - Whyte Company, Chicago, Ill., by Mr. George S. Whyte; American Electrical Works, Providence, R. I., by Mr. F. N. Phillips; Eddy Electric Manufacturing Company, Windsor, Conn., by Mr. M. E. Baird; Weston Electrical Instrument Company, Newark, N. J., by Mr. Charles D. Shain; Buckeye Electric Company, Cleveland, Ohio, by Mr. J. H. Cooke; Cosmopolitan Electric Company, Chicago, Ill., by Mr. Jacob Frank; Meysenburg & Badt, Chicago, Ill., by Mr. R. F. Schuchardt; Chicago Insulated Wire Company, Chicago, Ill., by Mr. Wiliam M. Smith; Sargent & Lundy, Chicago, Ill., by Mr. W. E. Pimlett; Anchor Electric Company, Boston, Mass., by Mr. N. Marshall; Dick, Kerr & Company, Toronto, Canada, by Mr. F. C. Armstrong; Partrick, Carter & Wilkins, Philadelphia, Pa., by Mr. E. Ward Wilkins; Fort Wayne Lamp Company, Cleveland, Ohio, by Mr. L. H. Rogers.

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NORTHWESTERN CONVENTION NOTES.

MR. C. S. KNIGHT, of the Fort Wayne Electric Corporation, Fort Wayne, Ind., secured many new friends among the delegates for the apparatus of his company.

THE NEW VITRIFIED CONDUIT of the H. B. Camp Company, Aultman, O., was brought to the attention of many delegates interested in underground work, by Mr. A. L. Daniels.

CAPT. W. L. CANDEE AND MR. G. T. MANSON, of New York, enjoyed the trip and put in many a good word for Okonite wire.

THE SPRAGUE ELECTRIC COMPANY, New York, had its interests looked after by its Chicago representative, Mr. E. B. Kittle.

THE JANDUS AND BUCKEYE LAMP interests were well taken care of by Mr. H. F. Edgar of Boston, Mass.

THE BRYAN-MARSH COMPANY, New York, was represented by its president, Mr. C. D. Marsh; Supt. S. E. Doane, and Mr. J. M. Hill, of the Western office.

MR. W. D. PACKARD, of the New York & Ohio Company, Warren, O., made many new friends among the delegates for the well-known Packard lamps.

THE COLUMBIA LAMP COMPANY, St. Louis, Mo.—Although Secretary Garrison was unable to take the trip, the company's interests were well taken care of by Mr. Geo. Rex, of the Chicago office.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY was well represented by Mr. Arthur Warren, of the Department of Publicity and Promotion, and by Mr. A. J. Wurts, the well-known inventor of the Wurts lightning arrester, manufactured by the Westinghouse Company.

MR. E. H. ABADIE, of the Wagner Electric Manufacturing Company, St. Louis, Mo., made the round trip in the interests of his company. Mr. H. A. Wagner had many friends among the delegates who regretted that he was compelled to leave the party at Milwaukee.

MR. GEO. A. McKINLOCK, president of the Central Electric Company, Chicago, left the ship at Houghton. The interests of his company, however, were well taken care of during the entire trip by Mr. W. P. Upham.

THE DEARBORN DRUG & CHEMICAL WORKS, Chicago, was represented by Mr. Robt. F. Carr, vice-president and general manager, and Mr. C. S. Keeler. This company has met with well-deserved success, owing to the gratifying results secured by those who have adopted its methods of treating boiler scale.

MR. THOS. I. STACEY, of the Electric Appliance Co., Chicago, and Mr. B. B. Downes, the company's Minneapolis representative, contributed in no small degree to the success and enjoyment of the trip.

MR. F. N. PHILLIPS, president of the American Electrical Works, Providence, R. I., and the company's Chicago manager, Mr. F. E. Donohoe, enjoyed the trip immensely.

THE WESTERN ELECTRIC COMPANY, Chicago, had one of its new inclosed arc lamps, without outer globe, hung in the main saloon. Mr. C. D. Wilkinson and Mr. L. K. Comstock explained its advantages to many interested delegates.

New Wabash
Fast Train East.

"The Continental Limited," a new fast train on the Wabash, now leaves Chicago daily at 12:02 noon, and arrives at Buffal › 5:00 A. M., New York 3:30 P. M. and Boston 5:50 P. M next day, with through car service. Ticket office, 97 Adams Street.

The Belknap Motor Co.

OF PORTLAND, ME.,

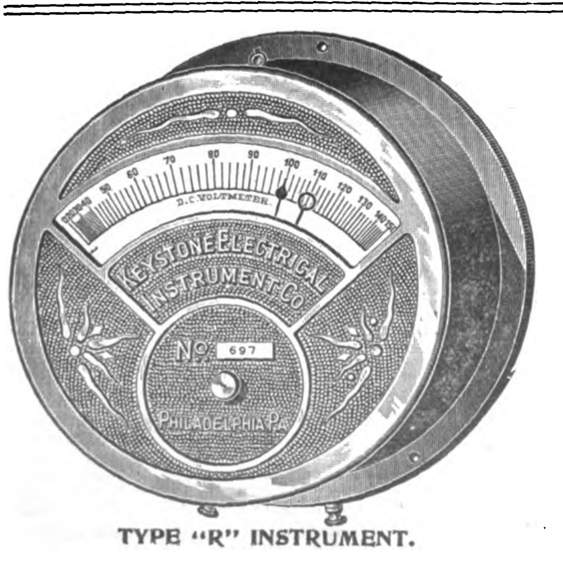
is very busy at the present time. They are just installing one 40 k.w. direct connected generator and engine in the new building of the Y. M. C. A., Portland, Me. They are also putting in a direct connected electric passenger elevator at the Falmouth Hotel, Portland, Me., in place of an hydraulic formerly in use. They have just completed an electric direct connected freight elevator for the Portland Packing Co., taking out an hydraulic. A hand elevator at E. D. Pettingell's Pickle Works, Portland, has just been taken out and a new direct connected electric has been put in its place by this company. They are also completing a new electric freight elevator for L. B. Griffin, produce dealer, Portland, Me., and have just received order for a direct connected electric elevator for the Hotel Jocelyn, Prout's Neck, Me.

Their direct connected elevator business has become very large; they have installed more elevators in Portland and vicinity in the last two years than all other companies combined. An electric conveyor for discharging vessels has just been installed by them for the Maine S. S. Co., and they have a contract from the same company for a second one. They had previously installed one for the International S. S. Co. at Eastport, Me.

The Chapman Voltage Regulator, manufactured by the Belknap Motor Company, is getting to be one of the most important parts of their business. The Mt. Morris Elec. Co. of N. Y. City, ordered two several months ago, and so well satisfied were they with the results accomplished by their use that they placed their order for seven more, all of which have been shipped to them.

The People's Elec. Co. of Orange, N. J., put in one several months ago, and liked it so well that they have placed their order for a second, which is about ready for shipment.

Frank Jones Elec. Lt. Co. of Portsmouth, N. H., has placed order with them for three of the No. 1 type, which are to be finely finished and erected on pink Tennessee marble, which will be in keeping with the balance of the plant.



TYPE "R" INSTRUMENT.

KEYSTONE ELECTRICAL INSTRUMENT COMPANY

Switchboard and Portable Voltmeters,
◉ . Ammeters, Ground Detectors and . ◉
. . Differential Voltmeters. . .

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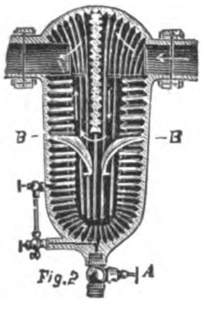

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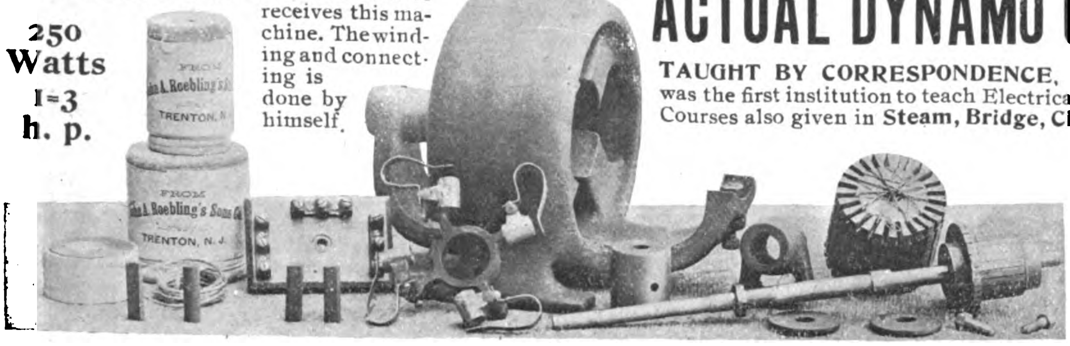

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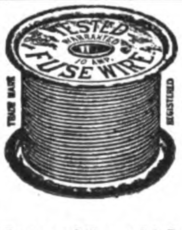

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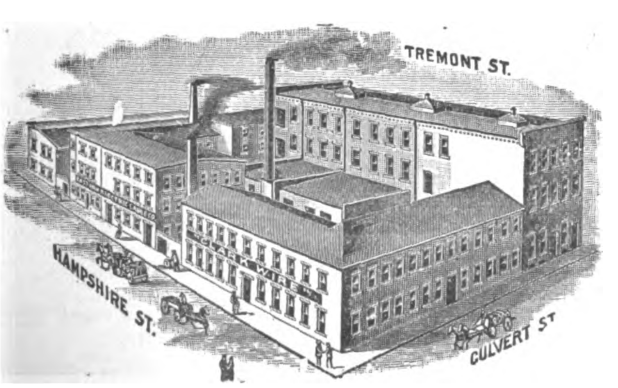
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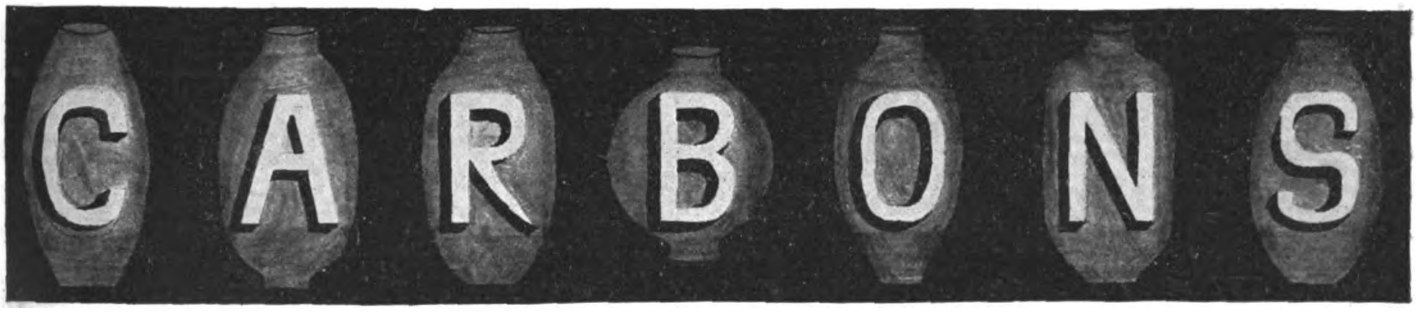

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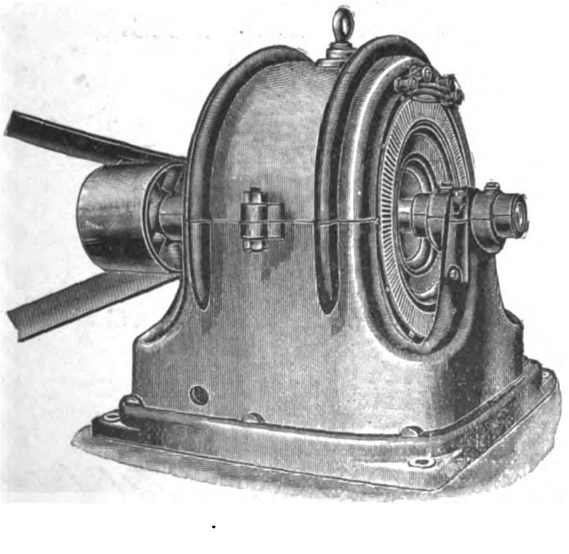

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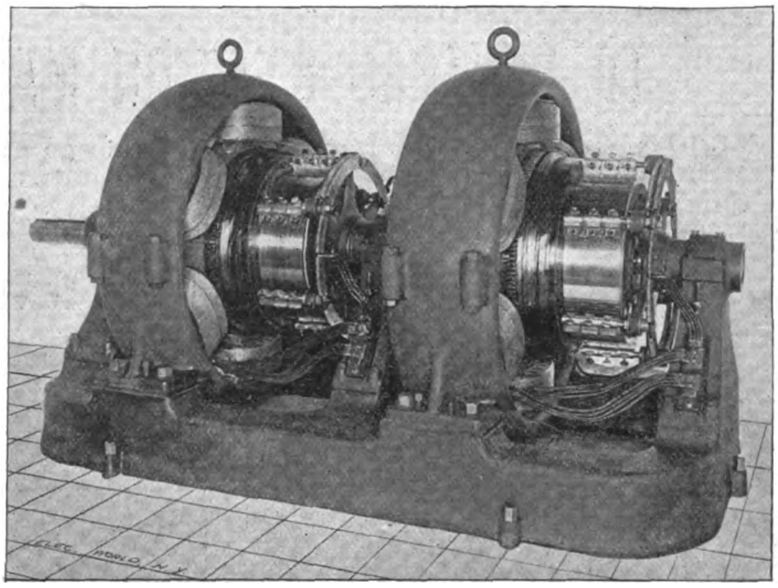

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American Electrician.

Vol. X. New York, August, 1898. No. 8.

STORAGE BATTERIES IN THE CUSHMAN BUILDING.

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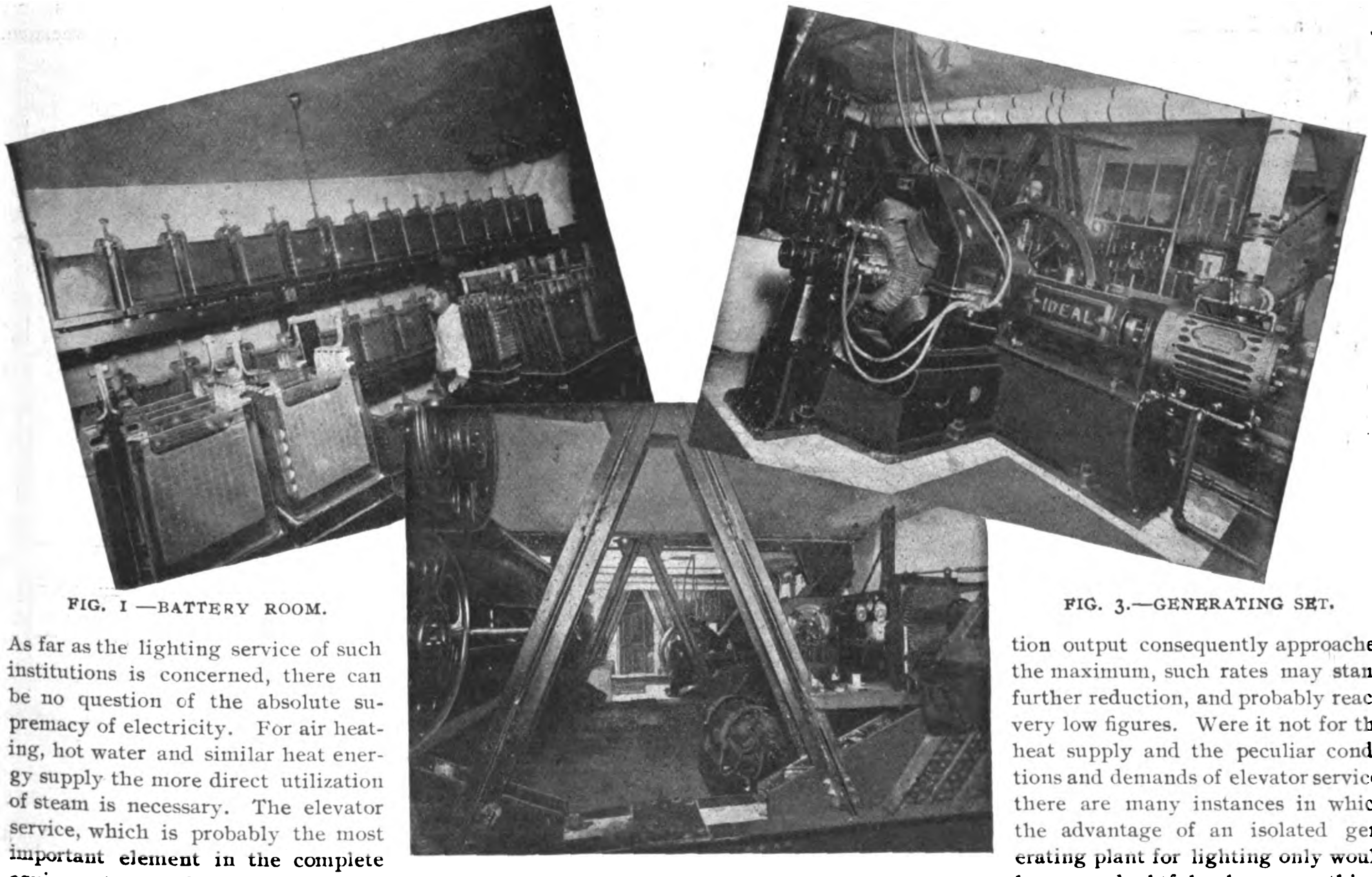


FIG. I —BATTERY ROOM.

FIG. 2.—GENERAL VIEW OF PLANT.

FIG. 3.—GENERATING SET.

As far as the lighting service of such institutions is concerned, there can be no question of the absolute supremacy of electricity. For air heating, hot water and similar heat energy supply the more direct utilization of steam is necessary. The elevator service, which is probably the most important element in the complete equipment, may depend upon either steam, hydraulic or electric power.

It is scarcely necessary to here discuss the relative merits of these methods. Ample experience has already demonstrated the value of the electric elevator, and many of its peculiar features are most strikingly illustrated in this novel installation which is the subject of this article. For ventilating purposes electric power is displacing in many instances all steam machinery for this purpose. It will therefore be seen that neither steam nor electricity can meet the demands alone, and it is only by a most careful combination that efficient results can be obtained.

Whether all or part of this heat, light and power service can be most economically and satisfactorily obtained from a private isolated generating plant or from a central station supply system is a question the solution of which is entirely dependent on the specific conditions in each particular case. Much has been said regarding the relative advantages of electric current supply from isolated plants or central stations. Yet the experience seems to indicate that, taking such service as a whole, the selling price of electricity supply from central stations must be very materially reduced before any very notable change will result in the installation of isolated electric generating plants. Electric supply central stations, operating large units combined to produce the maximum economy, can unquestionably generate electrical energy at a smaller cost per unit than it could be produced in the very much smaller isolated plant. The actual selling price to the consumer, however, is dependent on so many other considerations that it is only in the case of very large services that the rate can be reduced to figures which are at all enticing when compared with good isolated plant practice. Certainly as the demand on a certain station increases and the station output consequently approaches the maximum, such rates may stand further reduction, and probably reach very low figures. Were it not for the heat supply and the peculiar conditions and demands of elevator service, there are many instances in which the advantage of an isolated generating plant for lighting only would be very doubtful when everything, including space, interest, labor, depreciation and repair are considered. Central station electric service, where the elevator work may be ignored, or is a small item, undoubtedly presents many decidedly advantageous features.

As compared with the central station service, it may be noted that an isolated steam plant used for steam-hydraulic elevator service can, in many cases, with but a comparatively small additional outlay, and perhaps no additional labor expense, supply electric generating units. Here the steam-hydraulic elevator service constitutes the power and heating plant proper, of which the lighting element is but an auxiliary. The advantage and superiority of the electric elevator being acknowledged, a steam-electric generating plant which supplies light and power from one efficient set of generating units and heat from the exhaust steam energy used therein must certainly prove to be the best arrangement of isolated heat, light and power plant that will be most likely to combat central station encroachment.

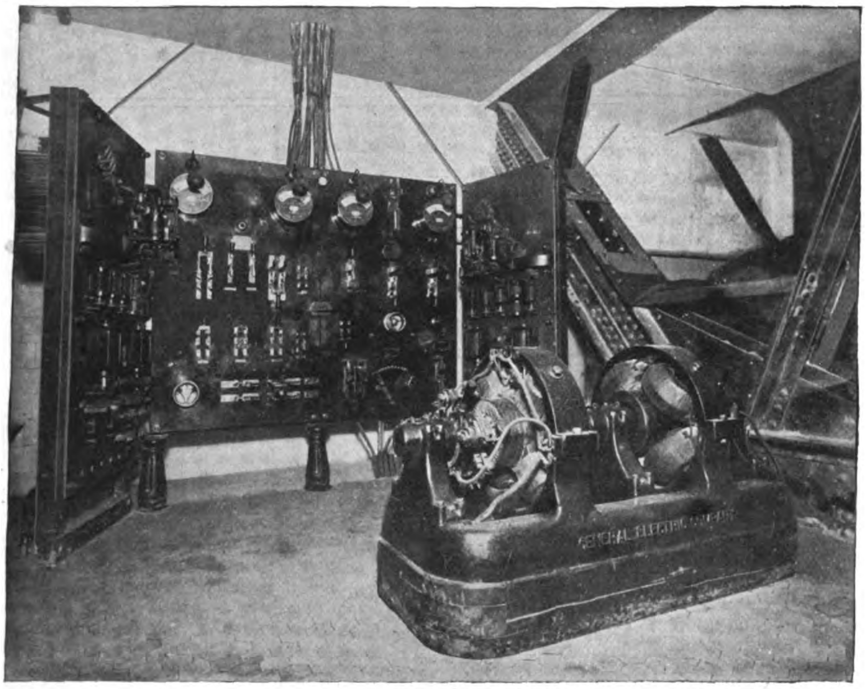


FIG. 4.—BOOSTER AND SWITCHBOARDS.

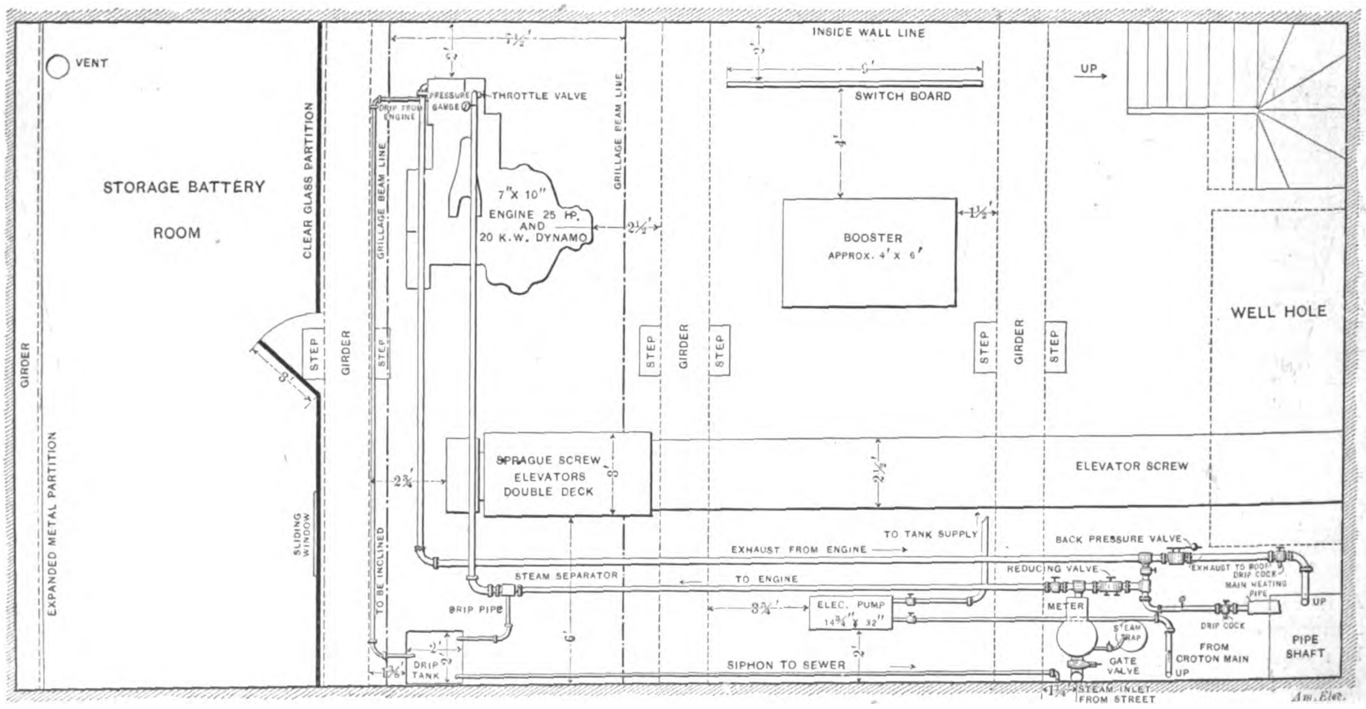

VENT
STORAGE BATTERY ROOM
CLEAR GLASS PARTITION
GIRDER
EXPANDED METAL PARTITION
SLIDING WINDOW
STEP
GIRDER
8'
STEP
GRILLAGE BEAM LINE
TO BE INCLINED
7½'
2'
PRESSURE GAUGE
DRIP FROM ENGINE
THROTTLE VALVE
7"X 10" ENGINE 25 HP. AND 20 K.W. DYNAMO
2½'
GRILLAGE BEAM LINE
2¾'
SPRAGUE SCREW ELEVATORS DOUBLE DECK
3'
STEAM SEPARATOR
DRIP PIPE
6'
2'
DRIP TANK
1⅝'
INSIDE WALL LINE
2'
9'
SWITCH BOARD
4'
BOOSTER APPROX. 4' X 6'
1½'
STEP
GIRDER
STEP
STEP
GIRDER
STEP
2½'
TO TANK SUPPLY
EXHAUST FROM ENGINE
TO ENGINE
3¾'
ELEC. PUMP 14¾" X 32"
2'
SIPHON TO SEWER
UP
WELL HOLE
ELEVATOR SCREW
BACK PRESSURE VALVE
REDUCING VALVE
EXHAUST TO ROOF
DRIP COCK
MAIN HEATING PIPE
UP
METER
STEAM TRAP
GATE VALVE
DRIP COCK
FROM CROTON MAIN
UP
PIPE SHAFT
1¼'
STEAM INLET FROM STREET
Am. Elec.

FIG. 5.—PLAN OF INSTALLATION.

The difficulties associated with the installation of a high pressure steam plant in buildings of the kind under consideration frequently overbalance the actual economy of operation of the isolated steam plant, and result in the adoption of central station electric service and perhaps a low pressure isolated steam heating service. Where, as in New York City, central station steam service can be obtained, it may even be advisable to adopt steam and electric central station supply, adopting an elevator service (either steam-hydraulic or electric) which best meets the conditions and can be most economically operated. On first consideration it would seem almost improbable that central station steam service, transformed at the customer's premises to electrical energy which is used for light and elevator service, while the exhaust is used for heating, would prove an economical and satisfactory combination. Yet a recently completed office building in this city has been equipped in this manner, and the apparent results have thus far been excellent.

The structure served in this novel manner is known as the Cushman Building, and is located at the northeast corner of Broadway and Maiden Lane. The lot occupied by the building measures 25 ft. x 50 ft. It is 13 stories in height, including the ground floor with basement, and sub-basement beneath. Each floor has five office rooms, with three stores on the ground floor. The foundation consists of five caissons topped by grillage beams, traversely across which five very heavy truss girders are placed—one every 12 ft. along the 50 ft. Maiden Lane side. The building proper rises above these girders in the standard iron skeleton construction. The adoption of the truss foundation beams was due to the desire to save this sub-basement space for vault purposes, but it is now occupied by the various machinery, and serves as the engine, elevator and storage battery room. The available space for machinery can readily be imagined when it is known that the originally small plot has not only been decreased by the foundation walls, but is cut up into four small divisions by the traversely placed trusses, each division measuring 12 ft. x 24 ft. The difficulty of moving machinery into this space, which is only 10 feet in height, can also be appreciated. The disposition of the machinery has, however, been so compactly arranged that the engine room, with its tiled flooring and enameled brick machinery foundation piers, has a "well put together air" about it.

The service to be supplied consists of about 500 incandescent lamps, two passenger elevators, heating and ventilating apparatus. The machinery arrangement for this service is shown in the diagram, Fig. 5 giving a plan of the engine room. A steam service from the New York Safety Steam Power Company's plant enters the building on the Maiden Lane side. The 3-in. service pipe connects with the standard meter of the steam company, and passes from thence to the engine. The piping arrangement also permits a supply of live steam to the heating system through a reducing valve, when necessary. The single steam electric generating unit consists of a direct connected Ideal horizontal engine and an Eddy multipolar dynamo operating at 300 r.p.m. This unit is shown in Fig. 3. The engine cylinder measures 7 ins. x 10 ins., and gives an output of about 25 h.p. at 80 lbs., which is the pressure of the steam supplied from the street service pipe. The dynamo is of the standard four-pole type, developing 20 k.w. at 230 volts. The exhaust from the engine passes through a 4-in. exhaust pipe, properly connected with the heating system and an exhaust head on the roof. All water of condensation, drip, etc., are handled by an automatically governed pump, which arrangement is made necessary by the fact that the engine room is below the sewer line. Hot water is supplied from a heating tank in which live or exhaust steam can be used.

The successful operation of the plant is really dependent upon the storage battery equipment, which, working in conjunction with the 20-k.w. dynamo, makes it possible to supply the varying elevator demands. This storage battery equipment occupies one of the previously mentioned end sections, and is separated from the engine room by a glass windowed partition wall. This part of the plant consists of 118 type 9F cells, furnished by the Electric Storage Battery Company, of Philadelphia. Each cell has four positive and five negative plates, measuring 10½ ins. x 10½ ins. The positive plates are of the Manchester type. These storage cells are mounted on wooden supporting tiers, each glass battery jar being placed on glass insulators. The cells are all permanently connected in a single series and have an output of 320 amp.-hours at a normal discharge rate of 40 amps.

This combined electric generating and storage equipment supplies about 500 16-c.p. incandescent lamps, located throughout the building; two Sprague screw and multiple sheave electric elevators, together with several pump and ventilating motors.

The operation of both lights and elevators from the same connected generating dynamo and storage battery at 230 volts gives excellent service, notwithstanding the exceedingly heavy starting currents required for the elevators.

Leads from the dynamo, battery elevators and the lighting mains are brought to the switchboard, which is located in one of the sections, as shown in the illustration. The main switchboard consists of two marbleized slate panels, centrally placed side by side between the two elevator regulator panels, which are set at a slight angle therewith. See Fig. 4. The left half of the main board is devoted to dynamo power and lighting circuit controlling switches and appliances, and the right panel is equipped with the storage battery switches, circuit breaker and booster regulators.

The arrangement of the switchboard permits of operating the elevators or lights separately on either the battery or dynamo. Separate ammeters and voltmeters are provided for each section of the switchboard, and a break down switch, controlling the bus bars, from which both light and power leads are taken, permits of operating the plant from a street service instead of the dynamo in case of necessity. All the lighting and power switches are arranged on the upper part of the left section. The storage battery section of the board is arranged so that the batteries are interposed between the lighting and elevator service, the potential of the lighting bus to which the dynamo is connected being "boosted" up while they are being charged.

The booster for this purpose is of General Electric manufacture, and is set immediately in front of the switchboard. It is of the separate and direct connected motor driven dynamo type. The motor and dy-

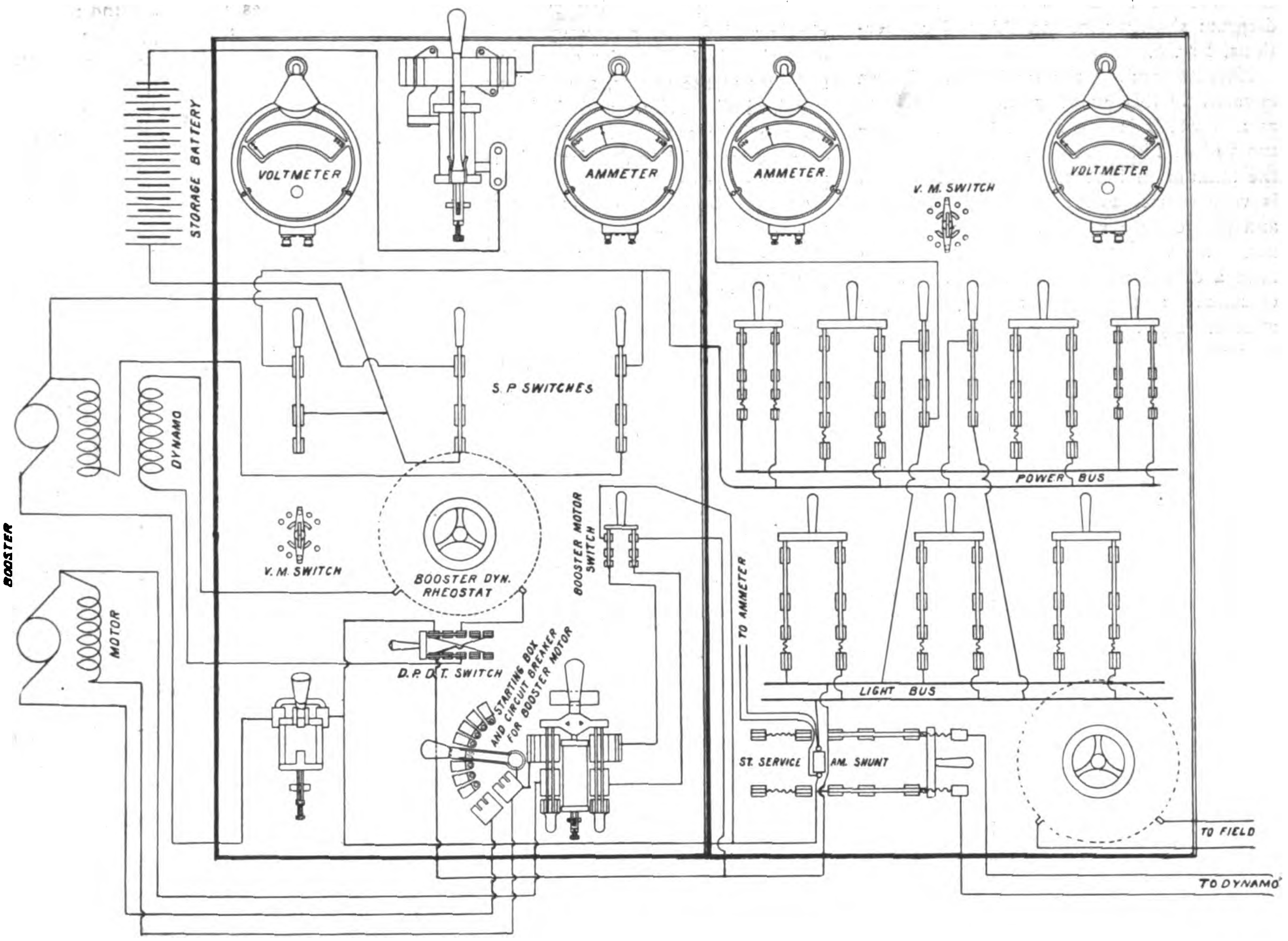


FIG. 6.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

namo are both multipolar, operating at about 800 r.p.m. Current for the shunt motor is supplied from the battery at 230 volts. The booster dynamo proper has a differential shunt and series winding, the latter being in series with the armature in charging from the dynamo, while the shunt field is connected in shunt across the bus. At times, after the battery has been fully charged, its potential is too high to operate the lamps. Suitable switches are therefore provided so that the connections of the shunt booster field may be reversed and its potential used to "buck" against the battery and lower the voltage supplied to the lamp bus when the engine and dynamo have been stopped. The detail connections and various possible arrangements of the different apparatus is shown in the diagram showing the switchboard connections, Fig. 6.

Notwithstanding the small ground area covered by this building and the fact that as a whole it is one of the "bijou" structures of its kind, yet owing to its location the amount of business transacted therein is very great. For this reason an ample and first class elevator service was essential. The two passenger elevators provided have a capacity of 2200 lbs. each, and the cars travel at the rate of about 300 ft. per minute. The hoisting machines are of the Sprague multiple sheave screw and sliding nut type, and were supplied by the Sprague Electric Company. Each machine is equipped with a 35-h.p. motor. They are 28 ft. in length and are arranged double deck—one on top of the other. In but few similar installations can such a striking exhibition of the superior features and absolute flexibility of the electric elevator be found. In fact, not only is the observer in doubt as to how the machines were placed, but he is also impressed with the undoubted fact that no steam-hydraulic elevator machinery could perform the same high class service in the space devoted to these electric machines.

The screw and sliding nut type of Sprague electric elevators is so well known that a description is unnecessary here. As the motors take current in hoisting only it is quite obvious that these machines cannot be load counterbalanced, or, as it is commonly termed, over counterbalanced, and therefore require larger starting currents than in the case of over counterbalanced machines. While this peculiarity of these elevator machines would, if street service or dynamo service alone were used, be objectionable when both lights and elevators are operated from the same bus, yet with the combination as here existing the variation in the lamp service with power and lights connected together is practically inappreciable when the battery and dynamo are serving as a unit. The satisfactory and economical operation of the plant and the fact that steam service used in this indirect manner has proven itself more desirable than either more direct steam machinery or electric street service is due to the fact that the electric elevator only takes current corresponding to its load, and the peculiar ability of the storage battery to average this varying demand.

All wires throughout the building, including the engine room, are run in "Armorite" (wood lined iron conduit.) Feeder circuits run from the switchboard to centers of distribution on the first, fifth and eighth floors. From these centers vertical mains run up and down, connecting with slate distributing panels on each floor, to which the several branch circuits are connected. Iron outlet boxes are used and the combination fixture wires are direct connected. The feeders are No. 6 B. & S.; the branch wires No. 14. Notwithstanding the small wire sizes used for the two wire mains and feeders, the loss from the switchboard to lamps is only 2 per cent. A single separate power main is also run to the top floor with a connecting outlet box on each floor. The wire used is the ordinary Simplex rubber covered single and duplex conductor, and the accessories, including the small fused knife switches at the panels, are of the ordinary standard dimensions and design. In fact no specially arranged devices have been deemed essential to satisfactorily serve 230 instead of 110 volts.

The water pumping service of the building consists of a small direct connected electric pump, operated by a 1-h.p. Lundell motor. Ventilating apparatus for so small a building with two sides exposed is entirely unnecessary, but a large direct connected fan ventilator is being installed in the engine room.

As far as the operation of the plant is concerned, it is quite obvious that since its completion several months ago the elevator service has been the main item. Owing to the small lighting load during the summer it has been unnecessary to run the dynamo continuously during the day, as is intended when the current demand warrants. At the present time the dynamo is operated from 8 A. M. to 1 P. M. feeding the battery, and in conjunction with it, supplying both light and power. From 1 to 4 P. M. the dynamo is shut down, and the battery used alone. From then until 6 P. M. the dynamo and battery are again operated together.

As the elevators descend without any current consumption and are operated so that one is ascending while the other descends, the current supply for this purpose is limited to the demands of the hoisting machine only. The character and magnitude of the demand can readily be appreciated from the fact that 125 amps. are required to start and 80 amps. to run each fully loaded car in ascending.

The adoption of this novel combination of—as it may well be called—central station and isolated plant service seems to be based entirely upon economical reasons. The operation of the plant up to date, with reasonable allowance for the increased winter heating and lighting load is claimed by the engineers, Messrs. Osterberg & Sutton, to indicate the correctness of their selection. A comparison of the following figures apparently shows a saving in favor of the steam-electric service as here adopted. They are furnished by the engineers who received the various proposals for each particular service for comparison.

Two electric central station supply companies would furnish street service current at 10c. per k.w.-hour, with a guaranteed minimum consumption of $250.00 per month. This rate included light and power service, with electric elevator machinery. Taking the minimum guarantee price as the probable value of the current consumption and allowing twenty-five service days per month, the cost per day would be $10, which, at the above rate (10c. per k.w.-hour) would mean a consumption, per day of ten hours, of 100 k.w. for that time. This figure is claimed to be lower than the actual average demand for all seasons will prove to be, and while it includes light and power the heating and hot water supply of the building still required separate consideration.

The installation of a steam-hydraulic elevator service was considered, and a proposal from the steam supply company gave the following flat rates, which were based on the probable steam consumption in such machinery at the rate of $60 per h.p. per year of ten-hour service days. For the elevator service, $1400 per year, and for heating service, $500 per year was asked. This proposition on the other hand did not consider lighting. Electricity for the lighting service of this 500 16-c.p. installation would be rated at figures coming close to the regular retail rates (1c. per 16-c.p. lamp hour).

Taking, therefore, the electric central station service minimum guarantee rate and adding the $500 for steam heating service, the cost per year would have been $3500.

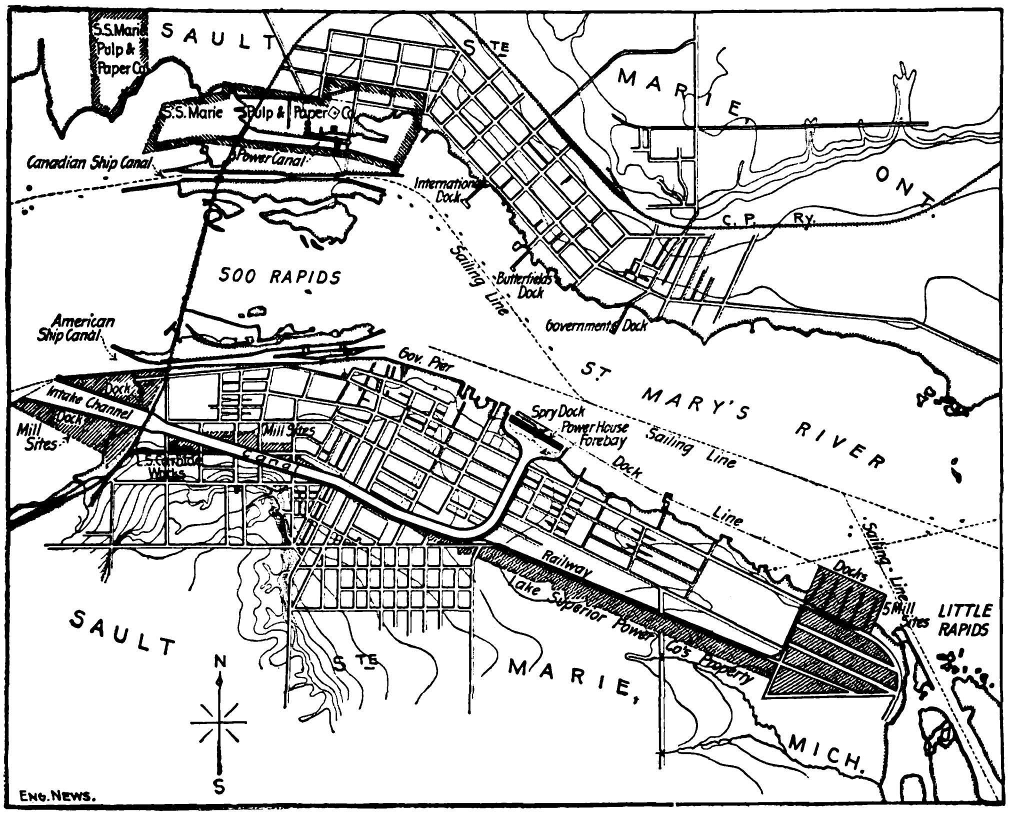
In case steam-hydraulic elevator service had been adopted the cost for this service and heating would be $1900 per year, with an additional amount of probably $600 or more per year for lighting and pumping, making a total of $2500.

In both of the above proposed central station services lamp renewals are included, but the labor and repair account would hardly be much less than with the present system. The superintendent of the building now serves as engineer, and has an assistant, and the additional items of repair and maintenance are the dynamo, engine and battery equipment. The plant has been in actual service for over two months with almost every office and all stores occupied. The bills for steam at the rate above mentioned, measured by meter, was for May, $70, and for June, $80. Allowing for the heavier lighting load during other months and the partial use of live steam for heating, if the exhaust should be insufficient, $100 per month would be a safe, in fact a large, figure to allow for the average monthly rate, making $1200 per year. In fact it is claimed that, allowing a fair amount for other items, a saving of over $500 in the cost of the heat, light and power service has been effected.

This novel installation will be watched with great interest. Osterberg & Sutton were the consulting and supervising engineers for the complete installation. The electrical work was installed by P. M. Mowrey & Company.

THE "SOO" WATER POWER.

Lake Superior has an area of about 30,000 square miles. Its mean outflow over the Sault Rapids section is about 90,000 cubic ft. per second. Its mean elevation is 601.5 ft. and the elevation of the Sault River below the rapids 582 ft. In the past there have been some attempts to develop this natural power. Some have failed and others have been partly successful. It has been left to the organization of the Lake Superior Power Company, the present owners of the water power privileges on both sides of the Sault Rapids, to compass the magnitude of the opportunity by a project which is worthy of it. The company consists for the most part of Eastern capitalists and manufacturers. The present officers of the company are: Mr. E. V. Douglas, of Philadelphia president; Mr. F. H. Clergue, of Bangor, Maine, vice-president; Mr. W. P. Douglas, of Philadelphia, treasurer. The company's headquarters are at 1420 Chestnut Street, Philadelphia, Pa. To Mr. Clergue belongs the credit of securing the operating privileges of the water power on both sides of the rapids, and under his guidance the company developed the power on the Canadian side, completing the hydraulic canal with the necessary construction capable of yielding 20,000 h.p. and a 40-grinder pulp mill. Over $1,000,000 has been expended in less than three years on the Sault water power. Within recent times additional right of way has been secured on the American side, but the prevailing unfavorable conditions for new industrial enterprises acted as an effective damper until the advent of a new commercial commodity made it possible to enter upon the construction of the greater Sault water power on the American side.


S.S.Marie Pulp & Paper Co.
SAULT
STE
MARIE
ONT.
S.S.Marie Pulp & Paper Co.
Canadian Ship Canal
Power Canal
International Dock
C.P. Ry.
SOO RAPIDS
Sailing Line
Butterfield's Dock
Government Dock
American Ship Canal
Gov. Pier
ST MARY'S RIVER
Dock
Intake Channel
Dock
Mill Sites
Mill Sites
L.S.Carbide Works
Canal
Spry Dock
Power House Forebay
Sailing Line
Dock
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Railway
Lake Superior Power Co's Property
Docks
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COURTESY OF "ENGINEERING NEWS"

FIG. 1.—MAP OF CANAL.

The Union Carbide Company, a concern which controls the manufacture of calcium carbide over a large portion of the United States, have made arrangements with the Lake Superior Power Company for an enormous carbide plant to be located at the Sault and requiring for a starter 20,000 electrical h.p. This the American Lake Superior Power Company have contracted to deliver at a not distant date. The remaining power to be developed, or at least a portion of it, will probably be devoted to the electrical reduction and concentration of the various silver and nickel ores, which the country north of the Sault is rich in.

The hydraulic part of this project is to divert a certain volume of water over the most direct and economical route between the upper and lower levels in sufficient measure to yield 40,000 mechanical h.p. at the turbine shafts. The Lake Superior Company came into possession of a right of way for canal location, which was selected some ten years ago by a now defunct organization. This location has been since regarded as a water power canal, if the old excavation and incomplete timber revetment entitles it to this distinction. In a measure this location is the logical one, for the intake from the upper level is fixed by conditions created by the existence of a Government ship canal. For this reason the canal must continue easterly to some point below the rapids. The old company located the canal easterly from Ashmun Bay, south of the southwest ship canal pier, for a distance of several miles to a point below the rapids, and this location represented a right of way from 150 to 400 ft. wide, which had to be acquired by the present company in order to secure the franchise and carry out the project.

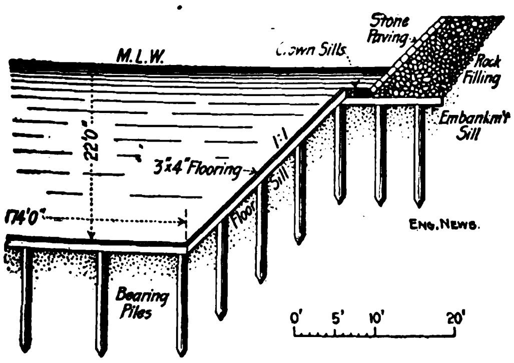
M.L.W.
Crown Sills
Stone Paving
Rock Filling
Embankm't Sill
22'0"
1:1
3"x4" Flooring
Floor Sill
174'0"
Bearing Piles
0' 5' 10' 20'
ENG. NEWS.

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FIG. 2.—CANAL SECTION.

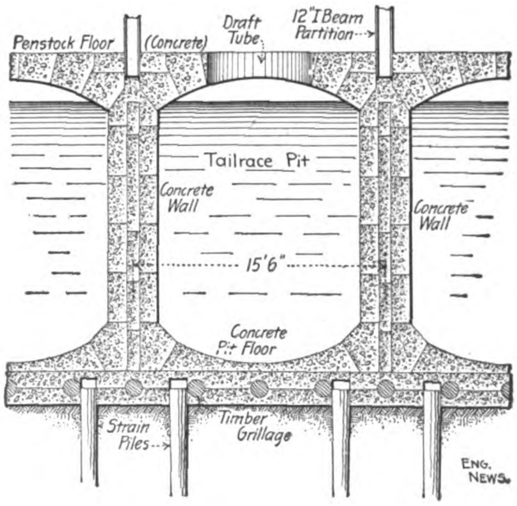
Penstock Floor
(Concrete)
Draft Tube
12" I Beam Partition
Tailrace Pit
Concrete Wall
Concrete Wall
15'6"
Concrete Pit Floor
Strain Piles
Timber Grillage
ENG. NEWS.

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FIG. 3.—POWER HOUSE FOUNDATION.

The location decided upon for the pending development follows the old one for about 6000 ft. and then curves northerly and debouches in the river shore a short distance below the nearest point on the rapids where private improvements can be made. The map, Fig. 1, shows the location to good advantage. The entire length of the proposed canal will be about 10,200 ft. The preliminary survey as to the physical character of the material resulted in the following data: For about 3000 ft. at the beginning of the west end of the location Potsdam sandstone comes to the surface, and for the remaining reaches the formation is sand, gravel, clay and boulders in undefined and irregular deposits, the sand largely predominating. The material of over two-thirds of the location cannot resist a transporting current of a mean velocity exceeding 3 ft. per second, and such a flow would require a sectional area in canal prism of about 12,000 square ft., or a width of about 450 to 500 ft. The lands adjacent to the old power canal have become settled and have been built upon, and the real or imaginary value fixed upon them by their owners prohibits any thought of acquiring much of it for right of way. The velocity of flow, therefore, had to be increased to something that could be safely maintained in the rock cut. It was fixed at 7½ ft. per second.

The canal capacity based on a development of 40,000 h.p. at the turbine shaft yielding 80 per cent efficiency, requires about 57,000 hydraulic h.p., or to be precise, an energy of 31,428,550 foot pounds. Computing the volume of water to produce this h.p. from the velocity, the effective head is found to be 16.5 ft., and a volume of water of about 4200 cubic ft. is necessary. The prism in the rock section is rectangular in design and is 200 by 22. The earth section prism is trapezoidal in form, with slopes at 45 degs. The dimensions are 174 ft. at the base, 218 ft. at the top, and 22 ft. deep. The slopes and base are to be substantially revetted with timbers, as shown in Fig. 2. The intake is 2400 ft. long, leading through a shallow bay to a navigable channel in the St. Mary's River. The prism is gradually widened at this place to 500 ft. at its mouth, the velocity being correspondingly lower. At the terminal of the canal below the rapids it widens out to 1400 ft. to meet the forebay, which is closed by the power house. For convenience in construction the canal is subdivided into the intake section, canal sections 1, 2 and 3, forebay and power house. The intake section extends from the navigation channel easterly to the river shore, traversing Ashmun Bay, a shallow sheet of water lying south of the Government ship canal pier above the rapids. The eastern portion is to be cofferdammed and a rectangular canal prism 200 ft. wide and 220 ft. below Lake Superior level is to be excavated dry. The western portion is to be gradually widened to a 500-ft. entrance and to be dredged to a depth of 18 ft. The sides of the dredged portion are to be retained by log timber cribs topped with stone-paved earth embankments. The terminal will be provided with bulkhead wharves 600 ft. long. Canal section 1 extends from the river shore 2800 ft. easterly. It is all in rock and a canal prism 200 by 22 is to be excavated, the sides being channeled. Section 2 extends for 3000 ft. easterly and is all of sand, gravel and clay. The canal prism through this section is trapezoidal, of the dimensions previously given. The revetment will consists of log timber sills, resting on bearing piles, the whole to be closely floored with deck planking. The slopes above the water surface will be stone paved. The third section extends by a 3-degree curve northerly for a distance of 3000 ft., terminating at the forebay. The construction is similar to that of section 2. The forebay consists of the gradual expansion of the conduit by similar curves east and west through a length of 1400 ft. and to a width of from 300 to 350 ft. The excavation of the forebay is to be the depth of section 3, the material being largely clay. The sloping banks are to be timber revetted, as in the other earth section. The power house foundation, see Fig 3, is to be about 1350 by 125 ft. wide. It will consist of a timber grillage laid upon stiff blue clay, resting against strain piles and surrounded by triple-lap sheet piling, filled and enveloped with Portland cement and concrete. The power house will consist of eighty-five units all similar in construction. The substructure is the wheel pit, composed of an arched forebay wall 13 ft. thick and 19 ft. high, and two wheel pits, 15½ ft. from center to center and 3 ft. thick. The wheel pit will be 92 ft. long and 19 ft. high and arched above and below. It will serve the double purpose of sustaining the superstructure of the penstock and mill walls and carrying off the tail water. The pit construction is entirely of Portland cement and concrete blocks keyed into each other by tongues and grooves. The penstocks are erected upon the pit and consist of two partitions, a roof and bulkhead. The partitions are of I-beam uprights with channel sills and caps. The frames are filled and faced with Portland cement grouting. The roof consists of steel frame trusses and the bulkhead is a steel plate cylinder secured to the floor and partitions.

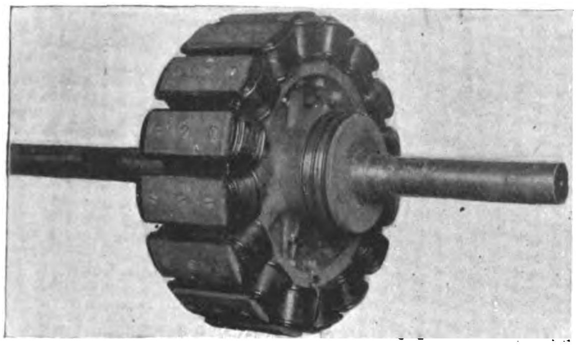


FIG. 4.—ROTATING FIELD MAGNET.

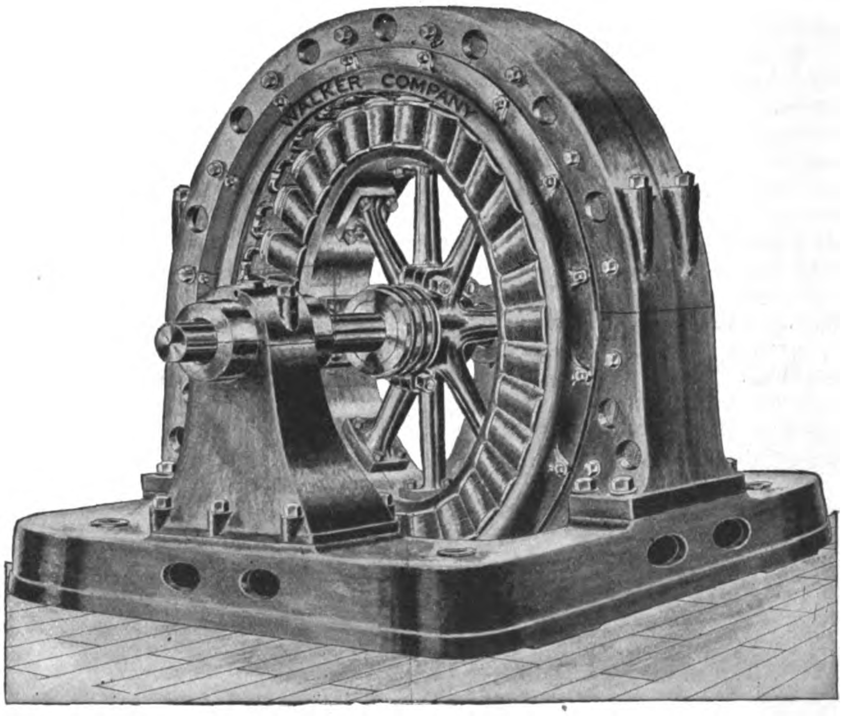


FIG. 5.—GENERAL VIEW OF ALTERNATOR TO BE USED AT THE "SOO" PLANT.

Two steel draft tube collars are inserted into each penstock floor and I-beam turbine supporting frames are constructed on the floor resting on the pit walls. The dynamo floor is the northern continuation of the penstock floor inclosure, being sandstone masonry mill walls. A second floor above is provided. Each penstock will contain two pairs of wheels with center discharge, coupled with a universal horizontal shaft, and will develop 500 h.p. at 250 r.p.m.

A movable headgate of wicker dam type is to be erected at the terminal of section 3, its superstructure being a highway bridge, and two floating service penstock gates of the dry dock gate type are to be constructed. Five of the penstocks are to be arranged for spillways, having together a discharge capacity equal to the total volume of water diverted.

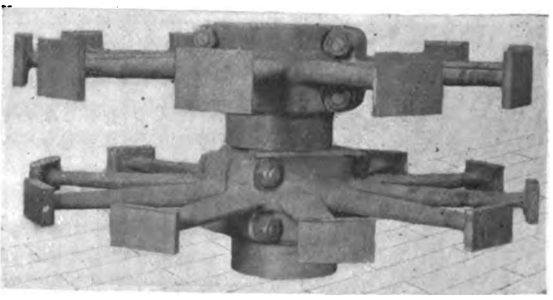
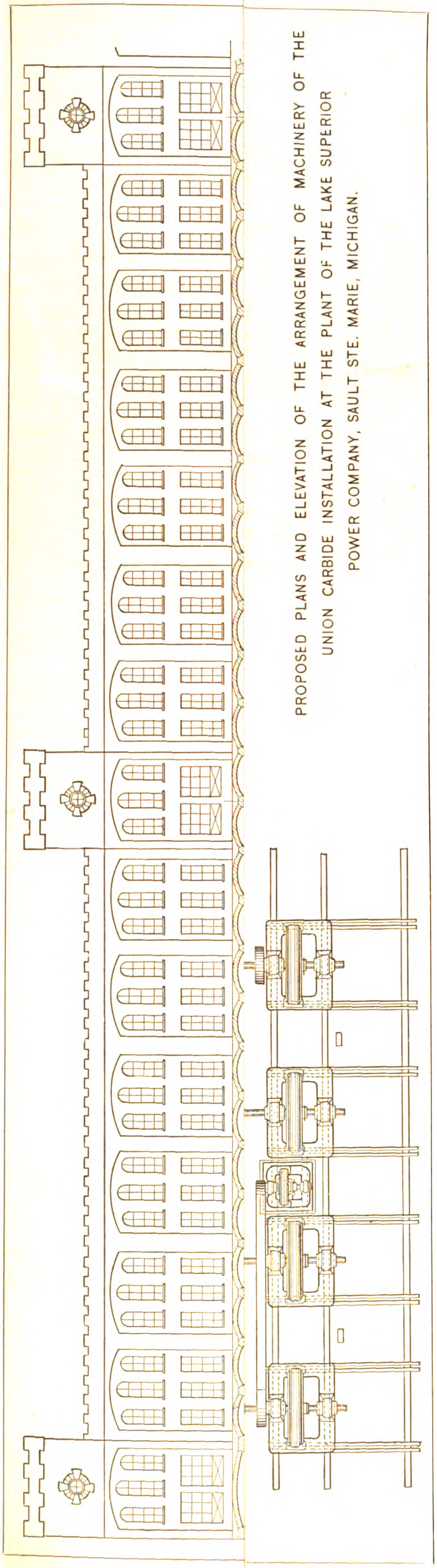


FIG. 6.—FIELD MAGNET SPIDERS.

The power house arrangements will be better understood by reference to the drawings on the inset page.



PROPOSED PLANS AND ELEVATION OF THE ARRANGEMENT OF MACHINERY OF THE UNION CARBIDE INSTALLATION AT THE PLANT OF THE LAKE SUPERIOR POWER COMPANY, SAULT STE. MARIE, MICHIGAN.

An idea of the gigantic proportions of this project can be gained from the following: The quantities of material to be moved are: 560,000 cubic yards of rock, 2,200,000 cubic yards of other material. The other materials required in construction are about 15,000,000 ft. of square timber, 2400 tons of structural steel, 300 tons of bolts and spikes, 70,000 barrels of Portland cement, 40,000 cubic yards of sand stone masonry, 25,000 cubic yards of sand, 60,000 cubic yards of broken stone, 320 turbines and 80 dynamos.

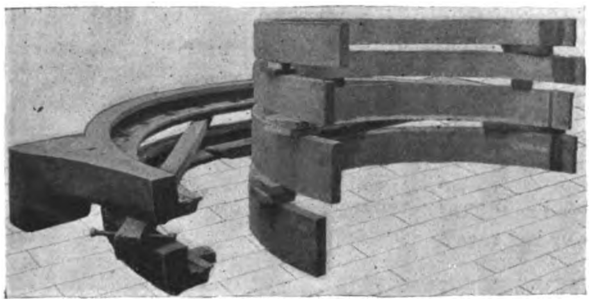


FIG. 7.—ARMATURE TRAINS AND FIELD MAGNET RINGS.

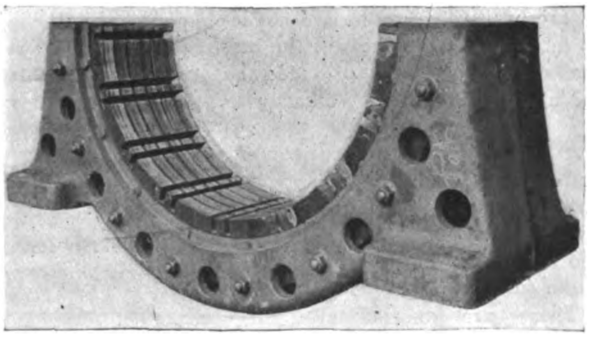


FIG. 10.—CONSTRUCTION OF ARMATURE.

All of this construction is to be completed in about two years.

The electrical equipment will consist of one 375 k.w. slow speed alternating current Walker dynamo coupled to each turbine shaft. The dynamos, as shown in the diagram on the inset page, are located on the first floor. They will deliver their output at a voltage of 200 and a frequency of 60 cycles per second. There will be ten belted exciters of 100 h.p. each. The arrangement is such that a single exciter can be belted on to the shaft of the machine next removed on either side, so that if one is shut down for any reason the belt can be shifted and applied to the other. The leads of the dynamo go directly to the furthest floor above. The currents are so large, that it is highly important that these leads be very massive, and, moreover, closely placed together to avoid inductive drop. The furnaces will be connected six in multiple with four machines, but only four furnaces are supposed to be in operation, and therefore a single furnace practically consumes the output of one machine. An arc of 200 volts and over 1800 amps. represents a deflagrating power of no mean proportions, and twenty furnaces each consuming such power as this will produce a great deal of carbide. The daily capacity of each furnace is three and one-half tons. The machines will be provided with the customary volt and ammeters, and in addition each will have a recording wattmeter.

A feature of interest in this plant is the construction of the Walker machinery, of which this is the first important installation. Inasmuch as the dynamos contain many distinctively new features, a detailed description will be in order. The machines have stationary armatures and rotating fields. A general view of the type of machine to be used at the Union Carbide Works is shown in Fig. 4. It has thirty poles on its field magnet and can deliver 375 k.w. at 240 r.p.m. The voltage is 200 and the frequency 60 cycles per second. The field magnet poles are all salient, each carrying a coil, as shown in the general view of the field magnet, Fig. 5. The construction of the field magnet is as follows: A massive cast-iron hub is provided with rotating arms. This hub is divided on a diameter, and the two halves strongly bolted together. Two finished hub castings are shown in Fig. 6, and it will be seen that the arms are not connected together by a continuous rim. In this way there is no danger of strain from expansion or contraction, such as might obtain if the rim was continuous. Mounted upon the ends of the arms are massive steel rings, which form a surface on which to mount the pole pieces, and also a return magnetic circuit for them. These rings, which are shown in Fig. 7, are securely bolted to the cast-iron arms of the hub, and to them the pole pieces are secured, also by bolts. The pole piece has a T-shaped section and is constructed of rather thick laminæ of iron, which are tightly compressed together and securely riveted, enabling them to be drilled and countersunk like a solid mass of iron. The pole pieces before drilling are shown in Fig. 8. It is to be noted that the polar surface is sloped away from the armature coil at the tips, thus shading the magnetic field and rendering the current wave less jagged. The winding on the pole pieces consists of flat copper ribbon, wound edge on with shellacked paper between. The winding is a somewhat difficult one to accomplish, but the bending is readily done by a special tool used by the company, and the result is extremely compact and mechanically secure, a very important consideration, this is moving wire. The bobbin is mounted on a spool with brass heads and a sheet-iron waist and the spool is sufficiently long, so that when the pole piece is bolted in place it compresses it very tightly in position. In this way there can be no shift nor movement. An idea of the general construction of the field magnet can be obtained by the photograph shown in Fig. 5, a picture of a Walker alternator field magnet of a smaller machine. Attention is called to the fact that this machine is wound with square wire instead of flat

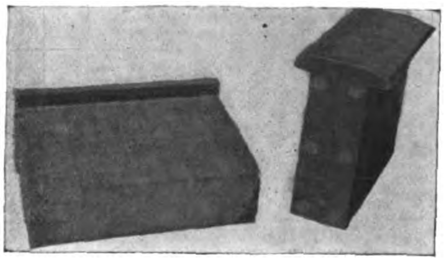


FIG. 8.—POLE PIECES.

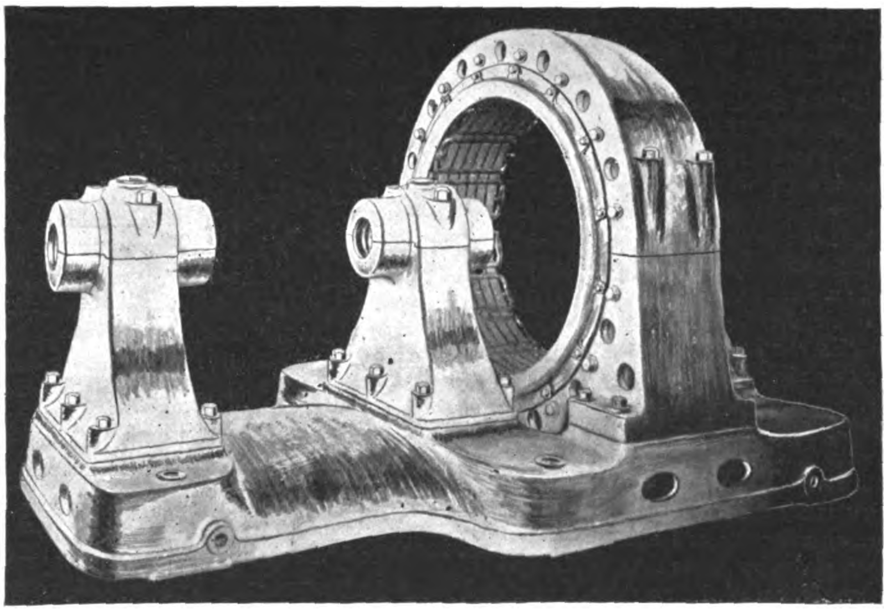


FIG. 9.—COMPLETED ARMATURE AND BEARINGS.

ribbon, and in that respect differs from the type of machine which is to be installed at the Union Carbide Works. It is easy to see that the bobbin is readily removed for repairs, by simply disconnecting it and withdrawing the two or more bolts which hold the pole piece in place. The field magnets are all connected in series and the terminals are brought down to two collector rings mounted on the shaft of the machine, the excitation being provided by means of a small standard Walker generator.

The armature construction is very simple and effective. The frame consists of four castings. It is divided both vertically at right angles to the shaft and horizontally parallel to the shaft. The vertical division of the frame serves to hold the laminæ in place. These are exceptionally large stampings of iron, deeply notched at proper intervals to receive the coils of the armature. These laminæ in sizes up to and even exceeding 100 k.w., consist of but a single piece for a half circumference. They are stacked together with the slots coincident and with suitable separator plates at intervals to provide for ventilation. The cast-iron halves of the frame are cored out sufficiently to admit of an air chamber behind the outer circumference of the laminae. The ventilating holes in the side of the casting, which appear in the photographs, give access to the outer air. The laminæ are insulated with paper and a sufficient number of them are placed in the armature frame, so that when the latter is set up by bolts parallel to the shaft they will be tightly clamped together. These bolts are never intended to be removed, and so they are set up with great pressure and the ends are closely filed off to the nuts. Fig. 10, a photograph of the lower half of an armature frame, displays its construction to good advantage. This frame is that of a single phase machine and is similar in construction to those to be used at the Carbide Works. If the machine were to be two phase, there would be intermediate notches at 90 degs. with slots for the single phase coils, and both sets of coils would have to be slightly bent in order to avoid each other.

The coils are wound on forms and are very heavily insulated, so heavily, indeed, that there is no necessity of insulating the armature core in any way; the coils are slipped on directly. They are held in place by two brass clamps secured by a single bolt. This construction renders the rapid removal and renewal of a coil very simple. The bolts securing the two halves of the armature frame together are external, thereby facilitating the dismantling of the machine and making all the parts easily accessible. The ends of the protruding armature coil are protected by cast-iron plates on either side, as shown in the general view of the machine, and also in the cut of the armature frame mounted on its bearing base, Fig. 9.

This latest essay of Prof. Short has proved remarkably successful. The first alternating machines, as designed and built at the Walker Works, immediately and satisfactorily responded to the demands for which they were built, and were sold at once, and the construction of others has been rapidly going forward.

The production of a line of alternating current dynamos is by no means as easy as a production of a corresponding line of direct current machines. The formulæ for proportioning the parts are more empirical and the principles less well understood, and it is surprising that such a complete line could be built at once without radical modifications from the original working drawings.

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INCANDESCENT LAMP RESISTANCE.

JOHN C. SHEDD, M. S.

Ordinarily resistance is defined as "*That property of a conductor by virtue of which under a given E. M. F., it limits the flow of electricity through it.*" **Another definition is** "*The ratio between E. M. F. of a circuit and the current flowing therein.*" **A third definition calls it** "*That property of a conductor by virtue of which it transforms electrical energy into heat energy.*"[*]

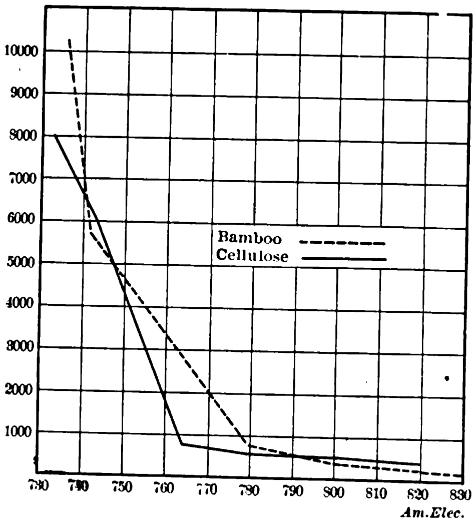

FIG. I.—SHOWING CHANGE OF RESISTANCE OF CELLULOSE AND BAMBOO FILAMENTS WITH RISE OF TEMPERATURE.

From the first definition we see why high resistivity is a valuable property in a lamp filament, since it is desirable that the lamps be placed across comparatively high voltage mains. The second definition enables us to predict the exact amount of current that will be taken; while the third shows us that the same property is depended upon for transforming the electrical energy into heat, and thence into light.

We too often look upon the subtle flow along the wire, as if it were merely the flow of an invisible fluid, and we fail to realize that it is in reality a flow of energy as well. Viewed from the latter standpoint, we are much better prepared to appreciate and understand the many really wonderful conclusions that have been reached in the study of electricity.

The difference in the two views is well illustrated by the two methods of rating in lamp service. One style of meter is so standardized as to record ampere-hours, and is specially designed for the particular voltage used. With the newer type the registration is in watt-hours, and is the more scientific of the two, giving as it does, directly, the amount of energy consumed.

It has been found by careful experimentation that the electrical energy transformed into heat in a circuit of resistance, R, in which a current, C, is flowing, is $C^2 R$, or the square of the current multiplied by the resistance.

We thus see that a filament of high resistance will transform a large amount of electrical energy into heat energy, and if the filament be of small enough bulk, the temperature may rise high enough to render it luminous. A good filament, therefore, should be made of a substance of high resistivity.

If the resistivity (i. e., the resistance of unit cross-section and unit length) of silver be taken as unity, that of the various conductors is given by the following table:

TABLE I.

RESISTIVITY OF VARIOUS MATERIALS:

Silver	1.
Copper	1.08
Aluminium	1.95
Platinum	6.
Iron	6.4
Lead	12.6
German silver	13.9
Platinum-silver	16.2
Graphite carbon	2,600.0 (about).

No better demonstration of the superiority of carbon, as a material for filaments, could be desired than is afforded by this table.

The next point to be noticed is the temperature coefficient; and here carbon presents an anomaly among solid conductors, of having a negative coefficient. That is to say, as the temperature of carbon rises its resistance falls. The effect of this is that a carbon filament behaves slightly differently from an iron or platinum filament.

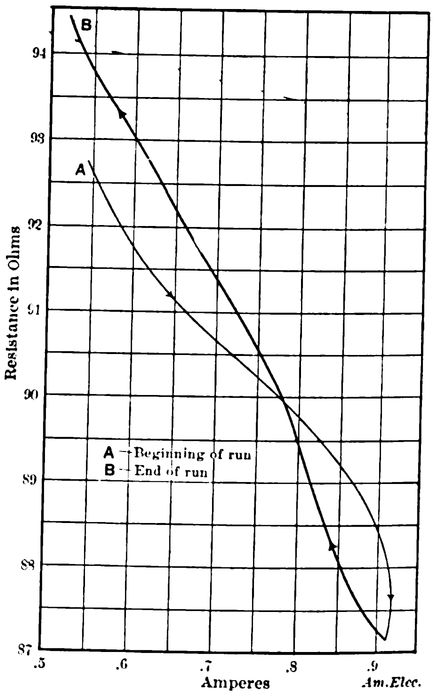

FIG. 2.—SHOWING CHANGE OF RESISTANCE OF FILAMENT DUE TO HIGH TEMPERATURE, LONG RUN.

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[*] Parham & Shedd, "Dynamo and Motor Testing," p. 69.—Carhart & Patterson, "Electrical Measurements," p. 15.

In the case of the metal, the current in the lamp would be greatest at the instant that it is turned on, and hence the lamp would flash out brilliantly, and then dim as the current is cut down by the rise of resistance. The rise of temperature in such a lamp upon turning on the current would be exceedingly rapid, and it may be that the frequent breaking down of the platinum filaments was due to this initial shock.

With the carbon filament the situation is reversed. Upon turning on the lamp the cold filament has its highest resistance, the current gradually rises as the resistance falls, and the lamp comes to its full brightness. There is then no initial shock as with the metal, and to this fact the long life of the carbon filament is partly due.

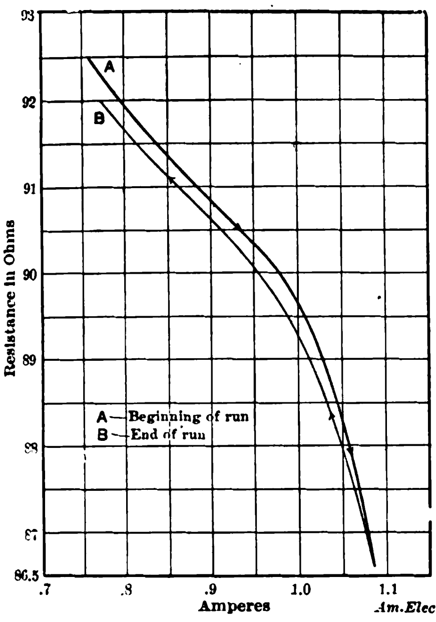


FIG. 3.—SHOWING CHANGE OF RESISTANCE OF FILAMENT DUE TO HIGH TEMPERATURE, SHORT RUN.

Comparing the temperature coefficient of carbon with those of other conductors we find the following table for cold resistances:

TABLE II.

RISE IN RESISTANCE PER DEGREE CENTIGRADE:

Substance.	Temp. Coef.	Rise in R. per deg. C
Silver	.004	.4 %
Copper	.0042	.42 "
Iron	.0065	.65 "
German silver	0003	.03 "
Carbon	—.0039	—.39 "

Thus if a silver wire had a resistance of 100 ohms at 0 degs. C., at 1 deg. C. it would measure 100.4 ohms, while a similar conductor of carbon would measure 99.61 ohms at 1 deg. C. It is not possible to assert that this law holds for all temperatures, and indeed, we are sure that it does not.

The study of the resistance of the carbon filament is exceedingly interesting throughout its history, from the time that it becomes a conductor, until, in a dim and blackened globe, it finally dies of old age. The following stages may be noted:

(1)—The lamp filaments, whether of bamboo or of cellulose (i. e., cotton thread—see article in March issue of "American Electrician"), are not at first conductors, but become so during the process of carbonization. The curves of Fig. 1 taken from an article by George Brian in the London "Electrician" for Feb. 8, 1897, show the change of resistance of the filament with rise of temperature, the latter being plotted horizontally.

(2)—Secondly, while at temperatures above 760 deg. C. the filament is a good conductor, yet the resistance will again rise with lapse of time, unless the temperature has been raised above 820 deg. C. At this temperature the resistance becomes stable.

(3)—In the third place, the resistance of a cold filament is about twice that of a hot filament, and its rise of temperature is about 1200 deg. Thus, a lamp that will measure, when cold, 180 ohms, will measure about 90 ohms when at full incandescence. An interesting point must be noted here. It was stated above that the temperature coefficient of cold carbon is —.0039, or — 39%. Now, if this remained constant for all temperatures, we can easily see that it would only require a rise of about 175 deg. to cause the resistance to fall to 90 ohms. But the temperature has risen about 1200 degs., and we must conclude that the temperature coefficient has correspondingly decreased. Thus the average temperature coefficient from 0 deg. C. to 1200 degs. C. for the above change of resistance would be .0004, or one-tenth its former value.

(4)—The fourth point to be noticed is, that when the filament is raised to an abnormal incandescence and again cooled, the resistance is found to have changed. The reason for this change is probably that at the high temperature the carbon begins to evaporate at a rapid rate, and so to change its structure somewhat. If the evaporation has gone on long enough the resistance of the filament is raised, as shown in Fig. 2, while in Fig. 3 the final resistance is found to be lower than before; due perhaps to the fact that the carbon in cooling has become more compact.

We thus see that there is a molecular disturbance and rearrangement, which goes on at high temperatures, and which is not altogether reversed as the temperature falls. This shows us that we are not to regard a lamp filament as an inert bit of carbon; but as an active agent, quivering with energy, which it is transforming with great rapidity into **heat and light.**

ARMATURE WINDINGS AND CONNECTIONS.

BY PROF. ARTHUR L. RICE.

CABLE WINDINGS.

It has been assumed, for almost all of the multipolar windings, that formed coils were to be used. This will be the case for armatures which are to be wound with rather small wire, say No. 8 or smaller. With larger sizes it is very difficult to bend the wire so as to get the formed coils into shape; also, with the large wire, there is comparatively little danger of a burnout from short circuit, requiring the replacing of an armature coil. Again, in machines where it is desirable to wind the wire more than two layers deep it is inconvenient to use formed coils, because different shapes will be needed for the outer and inner layers of coils.

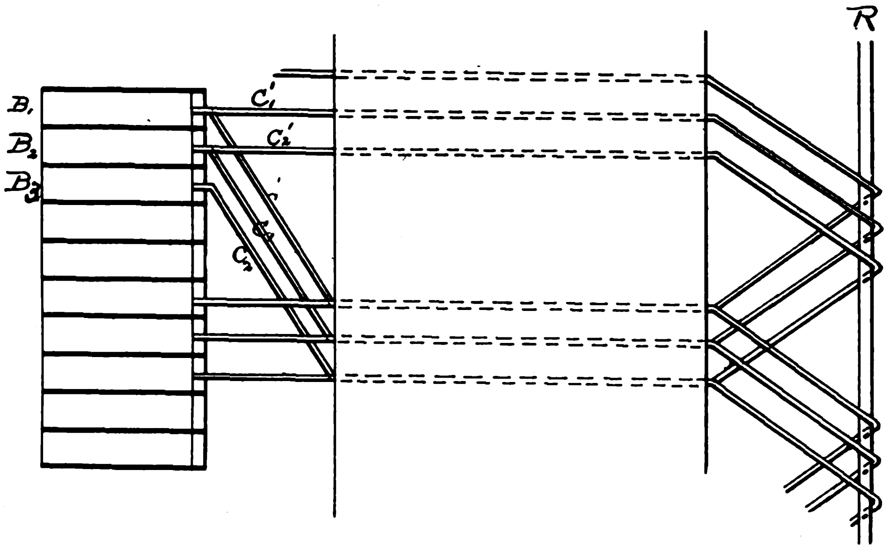


FIG. 1.—TOP VIEW, PART OF CABLE-WOUND ARMATURE.

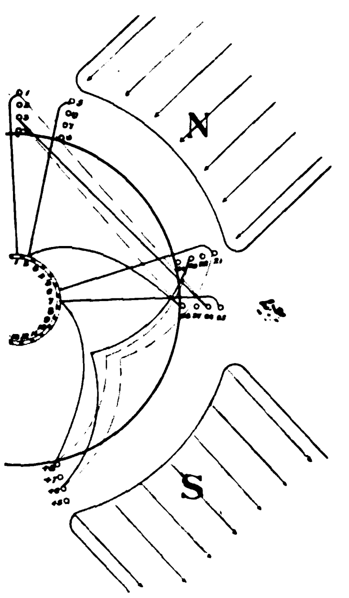


FIG. 2.—COILS FOR CABLE-WOUND ARMATURE.

For these cases, therefore—large wire, many layers and two-pole machines—the cable winding is used. The wire is cut in lengths and wound directly on the armature core by hand. For the sake of convenience in winding, several small wires in parallel are often used in place of one large wire; they form a single conductor, and are to be so treated. Generally there is but one turn per coil in two-layer armatures. The conductors are wound in slots which are either closed or nearly so at the top, and are wedged firmly in place after winding by a hardwood stick driven into the top of the slot. The slot insulation is made in the form of tubes of oiled muslin and oiled paper, which are slipped into the slot, and through which the conductor is pushed. At the back end of the armature, where the wires change direction in passing from one slot to another, it is necessary to have some means of holding the ends of the coils in position both during the winding and afterward during the running of the machine. For this purpose an iron ring—the "throat ring"—well insulated with tape is used. As in Fig. 1, the conductor, C_1, of the under layer is carried back from bar B_2 through the slot, and the back end is bent at such an angle as will carry it half way to the next slot which it is to enter. The same is done for C_2 and for all other conductors in the lower layer. The wires are bent somewhat toward the shaft, as well as being carried forward. When all the wires of the first layer are in place, the throat ring, R, is slipped over the back ends; these ends are then bent up and forward, shoved through the proper slot to the front of the armature, and carried to the commutator, C'_1 and C'_2. The position of the coil, when completed, will be as shown in Fig. 1. C'_1 and C'_2 are in the top layer.

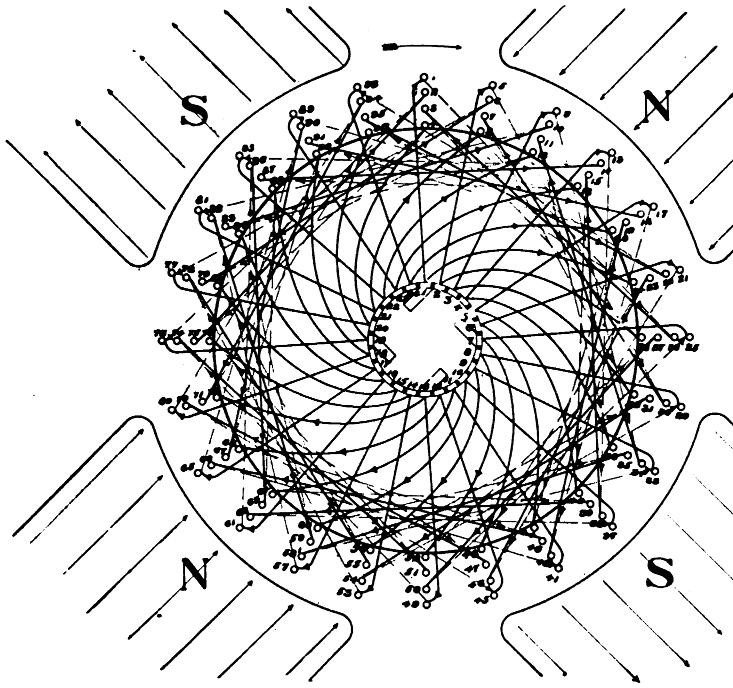


FIG. 3.—FOUR POLE FOUR LAYER, WAVE WINDING, CABLE WOUND.

From a consideration of the above it will be seen that the cable winding can be made of any size wire, but, as the wires must pass around the throat ring with a somewhat sharp turn it will be inadvisable to use a very large wire; No. 4 is as large as can be handled with any comfort, and this only on large machines.

The winding would be difficult to repair in case of a burn-out, and is not adaptable to a case where many conductors are to be wound into a single coil on account of the great amount of labor involved as compared with the winding by formed coils.

If more than two layers are to be used—as sometimes happens in a high-voltage machine, or in a low-voltage machine of the slow speed parallel circuit type, with a large number of poles and few slots per pole—it is hardly possible to use anything but the cable winding. In a four-layer winding, for instance, if the wire were small enough to work easily, two of the layers would be wound into one formed coil; but it would not then be a four-layer machine, since the two wires of one coil would be treated as a single conductor. If the wire needed is too large to wind into coils it must be wound up directly on the armature. Wire larger than No. 8 is to be avoided, except for the largest machines, on account of the difficulty of making the sharp bends required in winding on small armature cores.

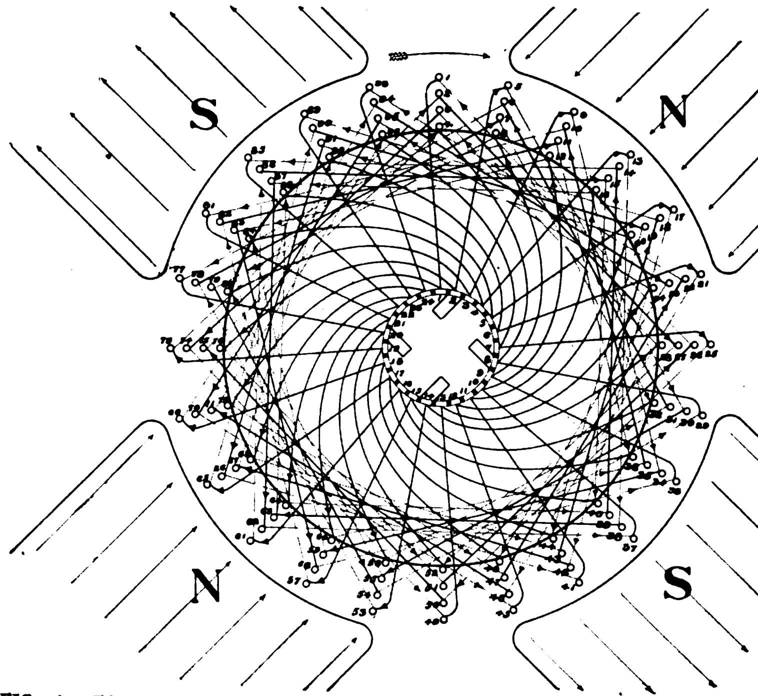


FIG. 4.—FOUR POLE, FOUR LAYER, WAVE WINDING, CABLE WOUND, PROGRESSIVE.

For a two-layer armature, the winding diagram will be the same whether cable or coil winding be used. For a four-pole machine which is to have four layers on the armature and has twenty-four slots there will be ninety-six couductors to be connected. Ordinarily, as a two-layer machine, the commutator would have twenty-four bars, and there would be two conductors per bar. It will be necessary, for economy's sake, to use the same commutator; also, if the winding is to be four-circuit, the number of coils must be divisible by four. Hence there must be four conductors per bar in the four-layer winding. Since it is to be a four-pole machine, conductors at approximately 90 degs. apart must be connected into a coil, and for twenty-four slots this gives $24 \div 4 = 6$ slots, or a coil must be made up of conductors in the first and seventh slots. Let the conductors be numbered as in Fig. 2. One conductor from each layer must be wound into a coil in order to make all the coils alike; to accomplish this the pitch must be odd, and it must be about $96 \div 4 = 24$. Naturally, 25 and 23 are chosen for back and front pitch, so that the average is 24. It would be necessary in any case to use unequal pitch front and back, for, suppose 25 were chosen for both, the winding would go from conductor 1 forward 25 to conductor 26, then back 25 to conductor 1, etc., and no progress would be made. In order to get a progressive winding, 25 is taken for the back pitch and 23 for the front, instead of the opposite arrangement.

The top conductors are supposed to connect straight down to the bar underneath. The winding then goes from bar 1 to conductor 1; on the back, forward 25 to conductor 26; on the front, backward 23 to conductor 3; on the back, ahead to conductor 28; on the front, to conductor 5 through bar 2, and so on. If the armature is small the winding will best be laid on as shown in the coil just considered; if large, it is better to use throat rings for holding the front and back connection as indicated in the coil which contains conductors 21, 46, 23 and 48, Fig. 2. The straight coils have been shown in the complete winding following (Fig. 3) for the sake of the greater clearness possible.

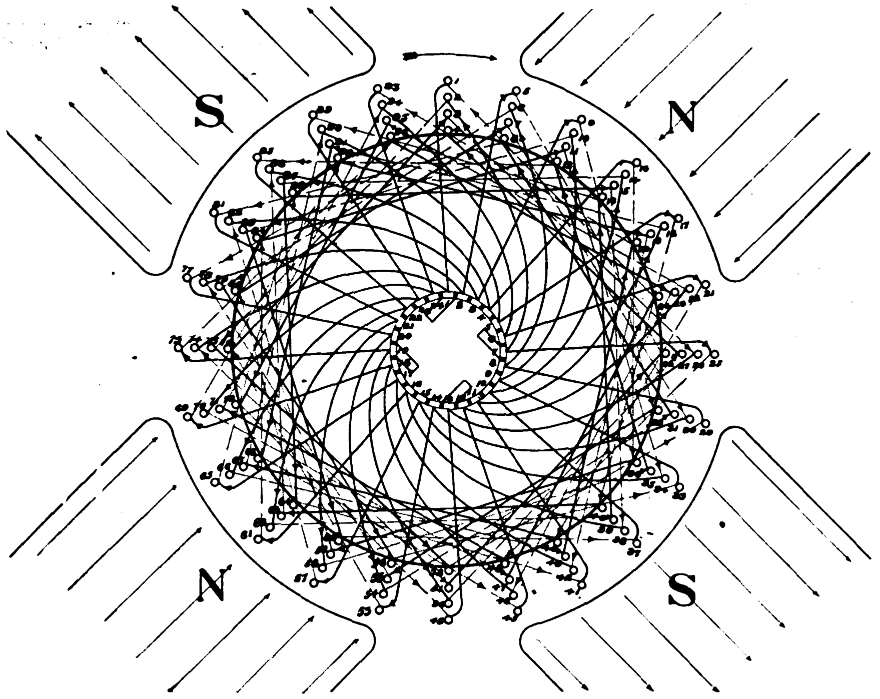


FIG. 5.—FOUR POLE, FOUR LAYER, WAVE WINDING, CABLE WOUND, RETROGRADE.

Between bars 1 and 2 there have been wound up four conductors—one from each layer—into a coil, as seen in Fig. 3. Electrically, this amounts to the same thing as a formed coil of two turns; mechanically, the difference is apparent.

It is important to so choose the actual front and back pitches that one conductor from each layer shall be taken in going from one bar to another, so that the winding shall be mechanically symmetrical. No rule can be given for doing this; it is a matter of inspection and trial.

By the direction of e.m.fs. the brushes are found to belong on bars 1, 7, 13, 19, at 90 degs., i. e., six bars apart; as there are four conductors per bar this gives 4 × 6 = 24 conductors, one-quarter of the number on the armature between brushes, which is correct for a four-circuit machine. To get the length of conductor needed between bars one coil should be wound in place and the length measured, allowing something for what will be taken up at the ends in crossing the other conductors.

In putting on the winding the wires in the bottom layer must all be put in place first, with the ends left long enough to connect to the commutator in the proper position. There will then be in place conductors 4, 8, 12, 16, etc., and the front end of conductor 28 must be long enough to reach around to bar 2.

When the lowest layer is in place the front ends may be tied down for convenience; the back end of conductor 28 is carried around to its place as conductor 3 above conductor 4, and the others are carried in the same direction and by the same amount, until all wires of the third layer are in place. The front end of conductor 3 is now carried forward to its position as conductor 26 in the second layer, directly over conductor 27, and in the slot where that wire started out as 28. All the other wires are carried ahead in the same way and by the same amount to complete the second layer. The back end of conductor 26 is then wound into its place above conductor 2 and becomes conductor 1, and the front end is carried straight down to bar 1; the other wires follow in the proper order, until the winding is complete.

If it is desired to make a wave winding—which has some advantage in point of convenience in winding and symmetry of the ends of the armature—either 23 or 25 may be used as the front and back pitch, because, by the condition for wave windings, $96 + 4 = 4 \times$ pitch; pitch $= 25$; or $96 - 4 = 4 \times$ pitch; pitch $= 23$. The same pitch must be used both front and back; 25 pitch will give a simple winding, as will be seen later.

The connection will be seen in Fig. 4. The winding starts at bar 1, goes to conductor 1, thence on the back ahead 25 to conductor 26; on the front ahead 25 to conductor 51; on the back ahead 25 to conductor 76; on the front to bar 2, which connects to conductor 5, 25 ahead of 76. There are four conductors between bars, and six bars between brushes, so that there will be $6 \times 4 = 24$ conductors per circuit, as in Fig. 3. The process of winding up will be the same as for Fig. 3, except that the wires must be carried ahead 25 each time as indicated in Fig. 4. The whole of one layer must be wound on before the next one is started.

If 23 had been chosen for the pitch conductor 1 would have connected on the back to 24, which is in the lowest layer, then to 47, which is in the third layer, and to 70 in the second layer, as seen in Fig. 5.

The lowest layer being connected to the uppermost layer necessitates a different order of winding. Of course, the bottom layer must go in place first, but, as the third and second layers have to go on before the outermost layer can be put in place the back end of the wires in the lowest layer must be left long enough to wind up later into the outermost layer, and the front end of the lowest layer will then be wound on as the third and second layers; the leads to the commutator will come from the outermost and the second layers.

The length of wire needed for a coil must be found, as for Fig. 3, by winding on one coil and allowing something for the crossing at the ends. The lowest layer of wires are all put in place with the back end of conductor 24 projecting far enough to allow of its being carried backward and laid in as conductor 1 in the top layer and then going to bar 1. The front end of conductor 24 will be wound up into conductor 47 of the third layer and conductor 70 of the second layer, and thence carried to bar 24. The back end of conductor 24 will then be brought around into place as conductor 1 and carried to bar 1. Each of the other wires will follow its similar course, as shown in Fig. 5.

THE PREDETERMINATION OF THE RESISTANCE IN CIRCUIT WITH DIRECT CURRENT MOTORS TO REDUCE THE SPEED TO A DEFINITE AMOUNT FOR VARIOUS CLASSES OF WORK.

BY P. M. HELDT.

In calculating the resistance that must be placed in circuit with a motor to reduce the speed to a given fraction of its normal value, one has to consider not only the characteristics of the motor, but also the nature of the load the motor is driving. It is required to know the torque the motor has to exert when running at this speed, which depends, of course, on the load. The problem then resolves itself into two parts, first, to determine the torque at the given speed, and secondly, to find the resistance which, when placed in circuit with the motor, will give the right speed. We will take up the last part first, supposing the torque to be known. In the latter part of the article some rules will be given applying to different classes of work, by means of which the torque at any speed can be calculated, when the torque at a certain speed is known.

A few explanations of terms used in motor work may enable those not familiar with them to better follow the methods of calculation given hereafter.

The mechanical energy delivered by the motor is composed of two factors, speed and torque. The speed is expressed in revolutions per minute and the torque in pound-feet. One pound-foot is a force of 1 lb., acting at a radius of 1 ft. from the center of the shaft. It must not be confounded with the foot-pound. The former is a measure of angular force, the latter of energy or work. If we represent the number of revolutions of the motor per minute by n, the space described by the point of application of the torque in one minute is $2\pi n$ ft. Multiplying this distance by the torque, T, we have for the work done in foot-pounds per minute,

$$\text{Foot-pounds} = 2\pi n T;$$

and as one horse-power is equal to 33,000 ft.-lbs. per minute, we have for the horse-power developed:

$$\text{H.P.} = \frac{2\pi n \text{T}}{33{,}000}.$$

From this equation we get:

$$\text{T} = \frac{33{,}000 \text{ H.P.}}{2}, \quad (1)$$

which enables us to calculate the torque when the speed and the power developed are known.

In Fig. 1 are given curves showing the relation between speed and torque of a shunt and a series motor when operated at constant potential. From the curve of the shunt motor it will be seen that this motor only drops slightly in speed as the torque increases. The drop in speed is proportional to the torque within the limits of the working range. The curve of the series motor shows a much larger variation of speed with the torque. This difference between shunt and series motors is due to the fact that in the former the magnetization is practically constant, while in the latter it varies with the torque.

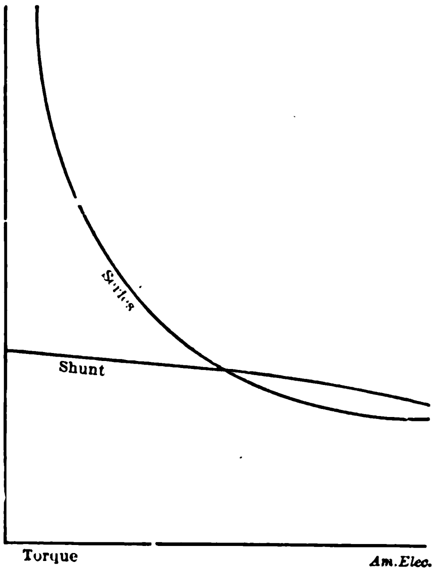


FIG. I.—CURVE SHOWING RELATION BETWEEN SPEED AND TORQUE OF CONSTANT POTENTIAL SHUNT AND SERIES MOTOR.

The following two equations hold for any direct current motor:

$$\text{Speed} = \frac{6 \times 10^{9} \times \text{E}}{\text{N} \times \text{F}} \text{ r.p.m.} \quad (2)$$

$$\text{Torque} = \frac{117 \times \text{N} \times \text{C} \times \text{F}}{10^{11}} \text{ lb.-ft.} \quad (3)$$

Here E is the back e.m.f. of the motor, N the number of armature conductors (twice the number of conductors in series), F the total magnetic flux through the armature, and C the armature current. Let us first apply these equations to the case of a shunt motor. Here N is constant, supposing that the brushes are not moved; F, the magnetic flux, is also constant, as stated above. In a shunt motor the speed is, therefore, directly proportional to the back e.m.f. and the torque to the armature current.

By torque here is understood not only the useful torque transmitted to the belt, but also the bearing and brush friction. The friction we may consider as independent of the speed, which is not exactly true, but it will simplify our calculations, while at the same time it does not introduce any serious error. Without any extra resistance in circuit there is only the resistance of the motor armature to cause a drop of potential. The approximate value of the percentage drop in voltage at full load in the armatures of well-designed motors of various sizes is as follows:

H.P.	1	3	5	10	15	25
Arm. drop. in per cent	6	5	4.5	4	3	2.5

In order to calculate the resistance necessary to bring down the speed to a certain value, we now proceed in the following manner: First, we determine the torque the motor has to exert at this speed. To this we add the brush and bearing friction. Next we find the ratio of this total torque to the total torque at full load. Multiplying the full load armature current by this ratio we obtain the armature current for the lower speed. (According to the principle, stated above, that the torque is proportional to the speed.) Next, we multiply the supply voltage, which is practically equal to the back e.m.f. when the motor runs free, by the ratio of the lower speed to the maximum speed, which gives us the back e.m.f. of the motor at the lower speed. The difference between it and the supply voltage must be used in overcoming the resistance of the circuit. Dividing this difference by the armature current we obtain the total resistance in circuit, and subtracting from this the armature resistance we have the resistance of the rheostat. This operation may be expressed algebraically, thus:

$$\text{R} = \frac{\text{E}}{\text{C}}\left(\frac{\text{n}-\text{n}^1}{\text{n}}\right)\left(\frac{\text{T}+\text{f}}{\text{t}+\text{f}}\right) - \text{r} \quad (4)$$

where R is the rheostat resistance, E the supply voltage, C the full load armature current, n the maximum speed, n^1 the lower speed, T maximum useful torque, t torgue at lower speed, f motor friction, and r the armature resistance. This formula is quite general and applies to any kind of work. There are various special cases for which it takes a simple form.

Supposing a motor running a pump used for pumping water into a tank, from which it is drawn irregularly. Let it be desirable to keep the tank nearly filled. When the demand on the tank is large the motor must run fast, when the demand is small the motor must run slow, and stop altogether when the tank is full. The torque the motor has to exert is greatest when the tank is full, because then the back-pressure of the water is greatest. When the tank is full the following conditions should therefore be fulfilled:

$$\text{t} = \text{T}; \ \text{n} = 0.$$

Substituting these values in our equation above, we find for the resistance to be placed in circuit with the armature:

$$\text{R} = \frac{\text{E}}{\text{C}} - \text{r} \quad (5)$$

In practice it is, of course, advisable to allow at least 10 per cent resistance more, because the motor may not have been geared exactly so that its torque counterbalances the maximum water pressure.

In a case where it is desired to have full control of the motor under any conditions of load, the resistance required will stop the motor even when there is no load on it. Here we have:

$$\text{t} = 0; \ \text{n} = 0$$

and substituting in the general equation we find:

$$\text{R} = \left\{\frac{\text{E}}{\text{C}}\,\frac{(\text{T} \times \text{f})}{\text{f}}\right\} - \text{r}$$

In this case it would generally be easier to measure the current that will just start the motor. Dividing the supply voltage by this current gives the rheostat resistance. This last case, however, rarely occurs in practice.

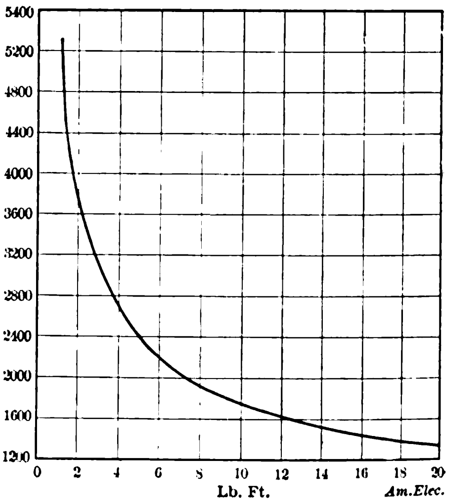


FIG. 2.—SPEED-TORQUE CURVE OF A 3½-H.P. SERIES MOTOR.

We may now work out a practical example to illustrate the foregoing. A 2-h.p. motor runs at 1200 r.p.m. without load. It is required to also run at 600 r.p.m., the nature of the load being such that at this speed the motor has to develop ½ h.p. It is required to find the resistance to be placed in circuit to effect the desired result. Applying our formula (1) we can calculate the torque at full load, and at the lower speed. It should be borne in mind that at full load the speed is not 1200 revolutions, but about 5 per cent less, which makes it 1140 revolutions.

$$\text{T} = \frac{2 \times 33{,}000}{1140 \times 6.28} = 9.2 \text{ lbs.-ft.}$$

$$\text{t} = \frac{\tfrac{1}{2} \times 33{,}000}{600 \times 6.28} = 4.38 \text{ lbs.-ft.}$$

We may assume the friction to be 10 per cent of the total useful torque of the motor:

$$f = .92 \text{ lb.-ft.}$$

Having thus fixed the friction and the armature loss, we have as the armature efficiency at full load 86 per cent. This gives for the full load armature current at 110 volts:

$$C = \frac{2 \times 746}{110 \times .86} = 15.6 \text{ amperes.}$$

The armature resistance is about .35 ohm. We may now substitute in formula (4):

$$R = \frac{110}{15.6}\left(\frac{1200-600}{1200}\right)\left(\frac{9.2 + .92}{4.38 + .92}\right) - .35$$
$$= 6.33 \text{ ohms.}$$

With series motors there is only one particular case which admits of ready solution, namely the case of constant torque. Here the magnetization remains constant, and formula (5) becomes applicable by simply substituting armature and field resistance for armature resistance. It thus becomes:

$$R = \frac{E}{C} - (ra + rf).$$

The field resistance is generally about equal to the armature resistance.

In all other cases where fairly accurate results are desired, we require a speed-torque curve, or at least the necessary data to construct one from. Such a curve for a 3½-h.p. motor is given in Fig. 2. This motor runs at 1600 r.p.m. when fully loaded. Let it be required to find the resistance that will cut down the speed of this motor to 1200 revolutions, the voltage being 110 and the power required at this speed 1½ h.p. The useful torque at the lower speed equals:

$$\frac{1\frac{1}{2} \times 33{,}000}{1200 \times 6.28} = 6.57 \text{ lbs. ft.}$$

The friction would be about 1 lb.-ft., and the total torque, therefore, 7.57 lb.-ft. The torque indicated by the curve is the total torque. The drop in voltage in armature and field at this torque may be put down as 8 volts, and the back e.m.f. at 110 volts would therefore be 102 volts. Looking now at our speed-torque curve, we see that at 110 volts and 7.57 lb.-ft. torque the speed would be 1970 r.p.m. The back e.m.f. at this speed being 102 volts, at 1200 revolutions it is $\frac{1200}{1970} \times 102 = 62$ volts. Forty volts must therefore be used up in the rheostat. To find the rheostat resistance we have to first find the current that will flow.

The mechanical energy derived from the motor plus the mechanical losses must be equal to the electrical energy put into the motor minus the electrical losses. If we express both in the same units, their numerical coefficients will be equal. We will express both in h. p. here:

$$\frac{\text{Back e.m.f.} \times \text{current}}{746} = \frac{(t+f) \times 6.28 \times \text{speed}}{33{,}000}$$

From this we get:

$$\text{Current} = \frac{(t+f) \times \text{speed}}{7 \times \text{back e.m.f.}}$$

This equation may also be obtained by multiplying together equations (2) and (3) and holds therefore for any direct current motor. In our present example we find for the current

$$C = \frac{7.57 \times 1200}{7 \times 62} = 20.9 \text{ amps.}$$

The rheostat resistance must, therefore, be

$$\frac{40}{20.9} = 1.9 \text{ ohms.}$$

The power that any machine requires at any speed may be found by actually running the machine at that speed, and measuring, with a dynamometer, the power it absorbs. Or, we can drive the machine at the required speed by an electric motor, the efficiency curve of which is known. The energy taken in by the motor may then be measured and this divided by the efficiency of the motor at this output. Both these methods are, however, mostly unhandy and often impossible, and recourse must then be had to calculation. A few remarks in regard to the factors that condition the variation of the torque in various classes of work may therefore be of value.

There is one class of applications of the electric motor in which the torque is independent of the speed, but varies periodically. As examples may be mentioned: The hoisting of weights, the pumping of water into a tank, and the operation of organ and other bellows. The pumping of water was considered above. The operation of organ bellows is now often effected electrically. The rheostat is operated automatically by the bellows. When the limit of pressure has been reached, all the resistance of the rheostat is in circuit and the motor stops. In case the motor is shunt-wound formula (5) should be used to calculate the rheostat resistance. A ¼-h.p. 100-volt motor, for instance, driving a small organ bellows, requires a rheostat of 60 ohms.

In another class of work, that of rotating propellers in a fluid, the torque varies as the square of the speed, and the power required as the cube of the speed. Under this head come electrically propelled boats, fans and ventilators. In the first of these the regulation is always effected by other means than a rheostat. Electric fan motors are, however, in most cases provided with a rheostat to reduce the speed. Reducing the speed of the fan to one-half reduces the torque to one-fourth and the power absorbed to one-eighth. The torque or power required at full speed is generally known, and that required at any other speed can therefore be easily calculated.

Electric elevator work really comes under the first division, but the conditions that govern the design of elevator controller rheostats are different from those in any other work. As a factor to start from, we have the time of acceleration of the elevator car, which is generally fixed before hand. It is desirable that the acceleration be constant, as this gives the least maximum stress on the motor for a given time of acceleration. From the speed of the elevator car, weight of moving parts and time of acceleration, the force required to produce acceleration is now calculated. To this is added the unbalanced weight of the elevator car and the friction. This force is reduced to the speed of the motor and is then equal to the torque the motor has to exert while the car accelerates. By the methods given above we can now calculate the current corresponding to this torque, and from the current and the supply voltage the rheostat resistance.

WINDINGS OF MULTIPHASE ARMATURES.

BY J. P. STONE.

The rapidity with which alternating-current machinery has come into practical use within the last few years, and the many different types of machines now in use, has brought forth a great variety of armature windings. Both ironclad and smooth-core machines have been built. Some have even been made without iron cores in the armatures, but these latter have not found very extensive application in this country, although at one time were quite popular on the Continent.

It is the object of this paper to describe a few of the most useful windings that are used in American practice.

While there is a wide variety of styles of armature construction, many of the windings will be essentially the same whether used on a revolving or stationary armature, and a description of one will answer for all.

In the examples given in this article the winding has been laid out as for a revolving armature, and it has been assumed that the windings (whether bars or coils) are laid in slots, and that the necessary connections are made at the ends of the armature. The end where the principal connections are made and the leads brought out has for convenience been called the front or collector end. The conductors lying in the slots on the periphery of the armature are shown diagrammatically by radial lines, and when there is more than one coil or bar per slot, which in practice are usually arranged vertically one over the other, the lower ones are shown in the diagram by radial dotted lines.

As the smooth-core armatures with pancake coils, and also the Gramme ring windings, are rapidly falling out of use, chiefly owing to difficulty of insulating them properly now that higher potentials are used than formerly, no examples of them have been given.

As the various methods of connecting polyphase armatures have been treated in a previous article no mention will be made of it here, and all three-phase diagrams have been shown connected "Y," and all quarter-phase diagrams have been connected in two independent circuits.

Usually high voltages are desired, and in such cases windings are generally adopted in which heavily insulated coils are imbedded in slots in the armature surface. Often one slot or coil per pole piece per phase is used, as this practice permits of the most effective disposition of the armature conductors as regards the generation of e.m.f.; such a winding is called a uni-coil winding, and will be described further on. If more slots or coils are used, or, as in the case of face windings, if the conductors are more evenly distributed over the face of the armature, the e.m.fs. generated in the various conductors are in different phases, and the total e.m.f. is less than the algebraic sum of the effective e.m.fs. induced in each conductor; but, on the other hand, the subdivision of the conductors into several slots or angular positions per pole, or, in the case of face windings, their more uniform distribution over the surface decreases the self-induction of the winding with its attendant disadvantages. It also utilizes more completely the available space and tends to bring about a better distribution of the heating of core and conductors. Therefore, in cases where the voltage and corresponding necessary insulation permits the conductors are sometimes spread out to a greater or less extent from the elementary groups necessary in cases where very high potentials are used.

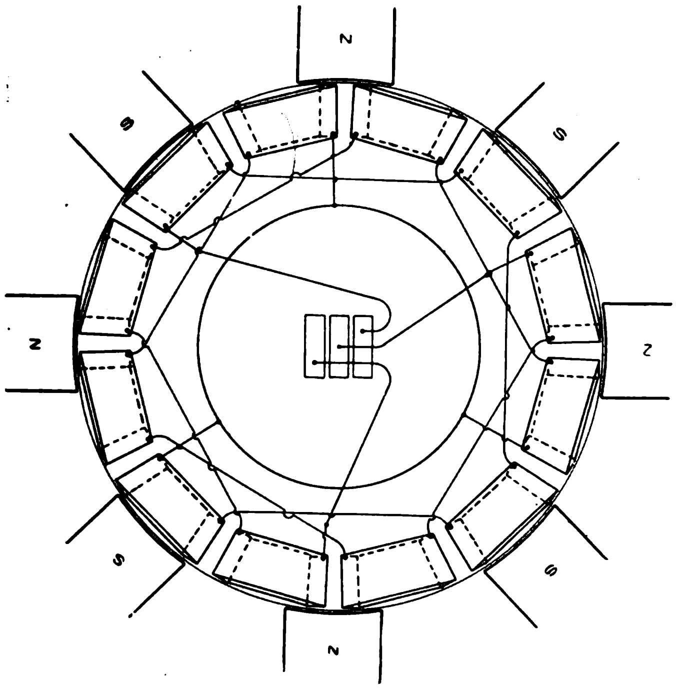


FIG. 1.—THREE-PHASE NON-OVERLAPPING UNICOIL WINDING.

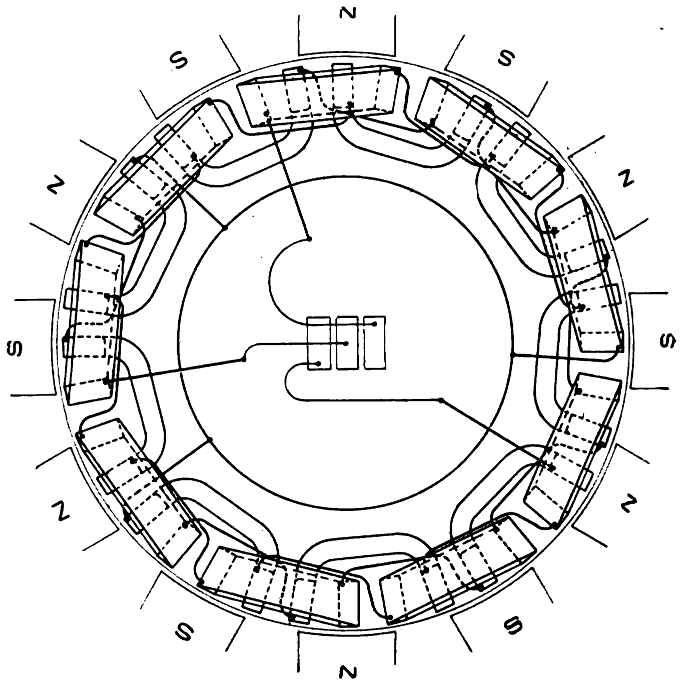


FIG. 3.—THREE-PHASE UNICOIL WINDING WITH OVERLAPPING COILS.

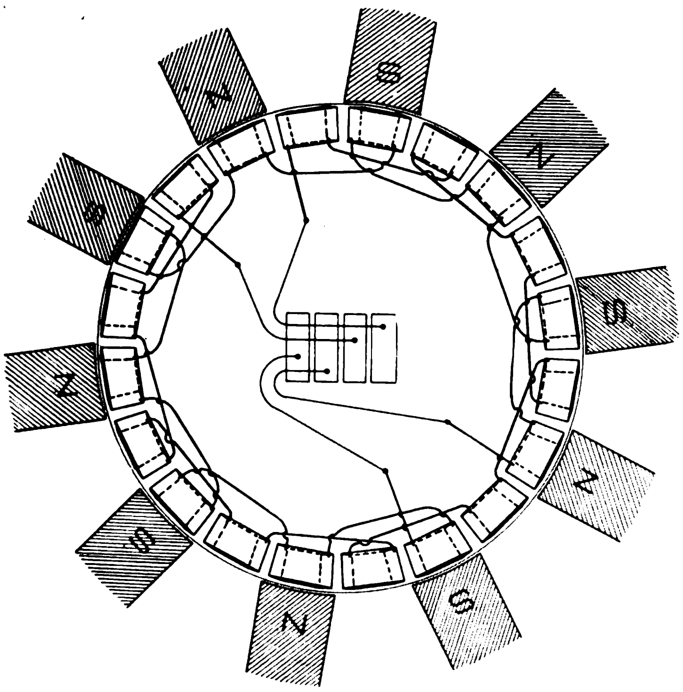


FIG. 2.—QUARTER-PHASE NON-OVERLAPPING UNICOIL WINDING.

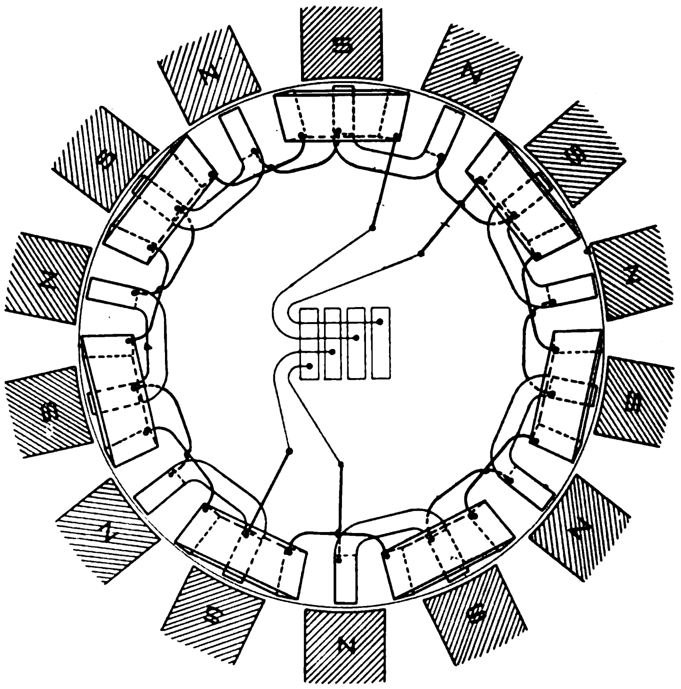


FIG. 4.—QUARTER-PHASE UNICOIL WINDING WITH OVERLAPPING COILS.

Windings in which such a subdivision is adopted are called a multi-coil winding, having two or more coils per pole piece per phase, as distinguished from the form in which the conductors are assembled in one group per pole piece per phase, which latter are called uni-coil windings, or windings having one coil per pole piece per phase.

It will be seen later that in most multiphase windings multi-coil construction involves only very little sacrifice of e.m.f. for a given total length of armature conductor and in good designs is generally adopted to as great an extent as proper space allowance for insulation will permit.

Often in alternating-current installations step-up and step-down transformers, or both, are used, and in such cases the other extreme is approached, and the apparatus is built for very low voltages. This permits the use of very small space for insulation, and conductors of very large cross section, often arranged in only one conductor per group, are used. Here the multi-coil construction is less difficult, although still attended to some extent with the disadvantage of obtaining less than the maximum possible voltage per unit length of armature conductor.

Examples of windings adapted respectively to both the above extremes will be given.

With a given number of conductors arranged in a multi-coil winding, less terminal voltage will be obtained at no load than would have been the case if they had been arranged in a uni-coil winding, and the discrepancy will be greater in proportion to the number of coils into which the conductors per pole are subdivided, assuming that the spacing of the conductors is uniform over the entire surface.

Thus, if the terminal voltage at no load be taken as 1 for a uni-coil construction, it will, for the same total number of conductors, be .7 for two coil, .67 for three coil, .65 for four coil, etc.

But, when the machine is loaded, the current in the armature causes reactions which play an important part in determining the voltage at the generator terminals, and this may only be maintained constant as the load comes on by increasing the field excitation, often by a very considerable amount (this is overcome by the Stanley Company by having the armature winding so arranged that more turns may be switched into circuit at full load than at no load, thus maintaining the voltage constant). Now, with a given number of armature conductors, carrying a given current, these reactions will be greatest when the armature conductors are concentrated in one group per pole piece, that is, when the uni-coil construction is adopted, and they decrease to a considerable degree as the conductors are subdivided into small groups over the entire surface; that is, they decrease when the multi-coil construction is used.

Multi-coil design also results in a much more equitable distribution of the conductors, and, in the case of ironclad construction, permits of coils of small depth and width, which require less insulation for the same amount of wire.

The form of the potential wave of the machine is also determined to some extent by the style of winding adopted, being more peaked as the conductors are concentrated; as in the case of a winding having one coil per pole piece per phase the potential curve is very sharp or peaked, and becomes more flat and rounded as the

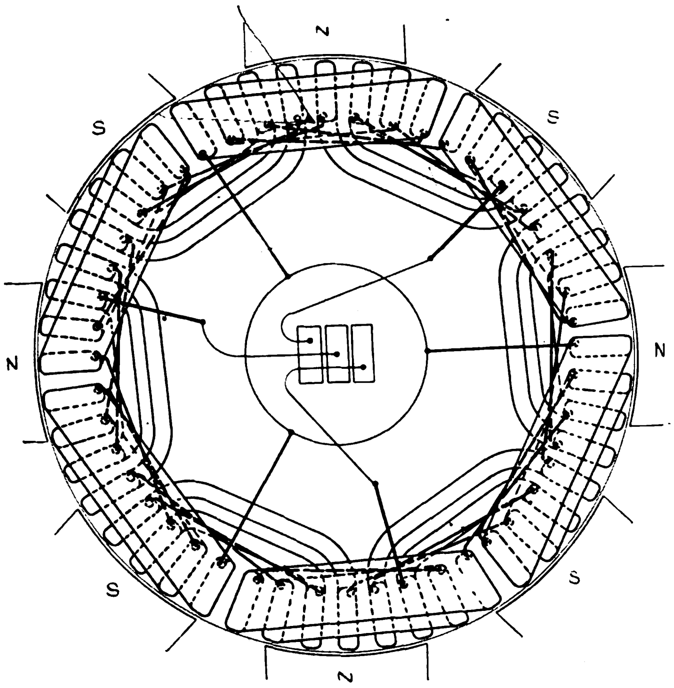


FIG. 5.—THREE-PHASE MULTICOIL WINDING WITH TWO COILS PER POLE PER PHASE.

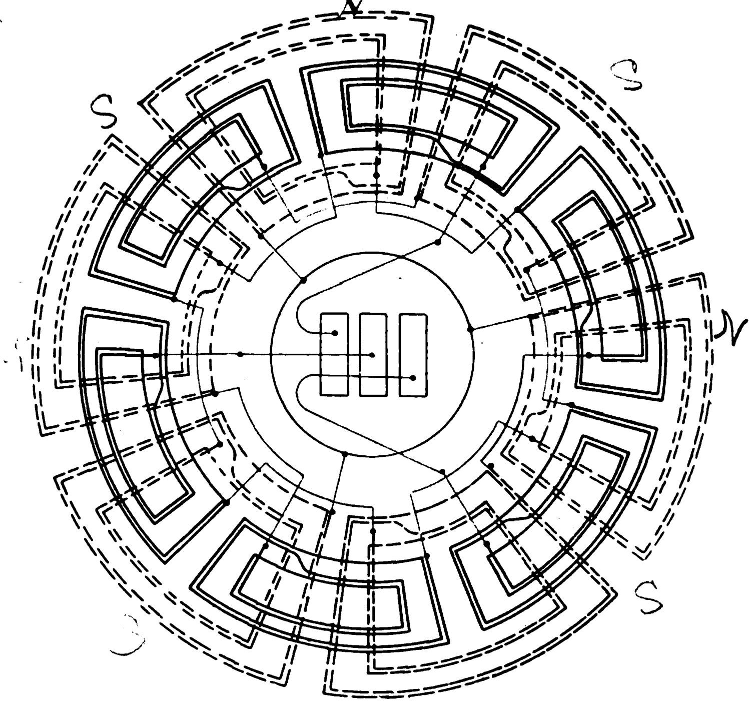


FIG. 7.—THREE-PHASE MULTICOIL WINDING, HAVING TWO SLOTS PER POLE PER PHASE.

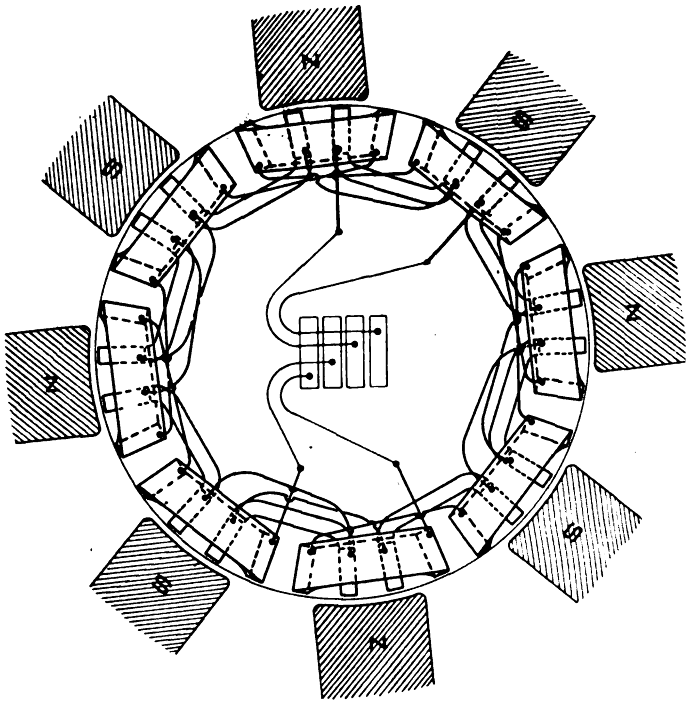


FIG. 6.—QUARTER-PHASE MULTICOIL WINDING WITH TWO COILS PER POLE PER PHASE.

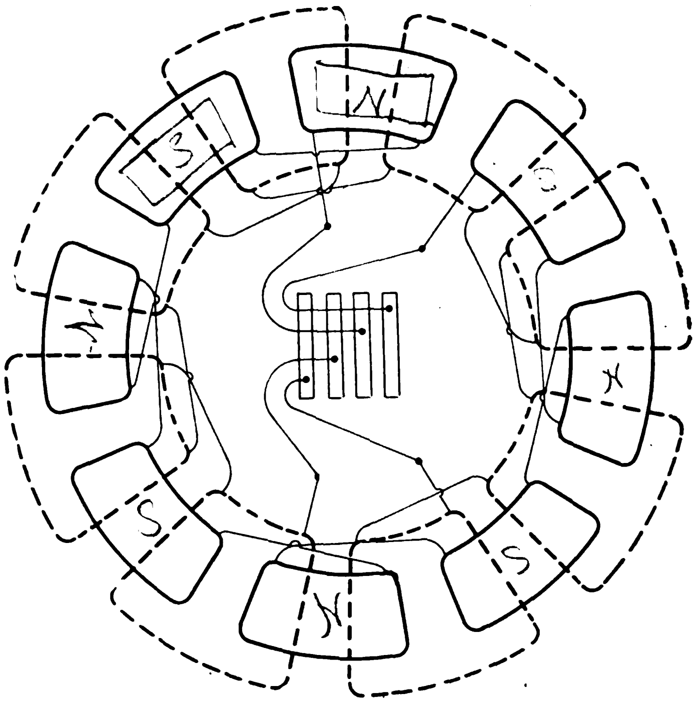


FIG. 8.—QUARTER-PHASE MULTICOIL WINDING, HAVING TWO COILS PER POLE PER PHASE.

winding is spread out, until with a uniformly distributed winding a sine wave is produced.

Usually if the winding is arranged in three or more coils, or groups of conductors per pole piece per phase, the curve of e.m.f. is sufficiently close to a sine wave to fulfill most requirements.

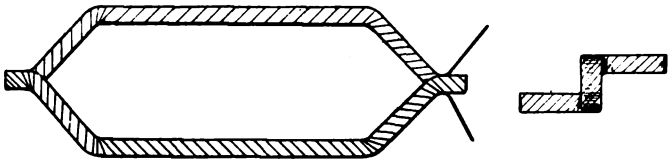


FIG. 9.—FORMED COIL FOR DRUM WOUND ARMATURE.

Thus, it will be seen that the type of winding to be adopted may, in a general way, be determined by the form of wave shape desired, and possibly make a type of winding necessary that for other considerations would not be used.

A class of apparatus, such as rotary converters, is now being found of much value in various ways. They are in a general way used for feeding continuous-current circuits from alternating (single or multiphase) circuits, and sometimes for feeding alternating circuits of one class from those of another, thus, for instance, transforming from single-phase to three-phase or quarter-phase, etc.

UNI-COIL WINDING.

The first winding we will consider is the non-overlapping uni-coil winding, having only one group of conductors per pole piece per phase. The end connections for both a three-phase and quarter-phase armature are shown in Figs. 1 and 2 respectively, as will be seen from an examination of the diagrams; this is necessarily a fractional pitch winding; that is, the pitch, or spread, of the coils is less than the distance between the centers of pole faces, so that the coil can never embrace the total flux coming from one pole piece, especially in the case of the three-phase winding, and will not in the quarter-phase winding unless the pole arc is very small. This fact renders the winding objectionable from an electrical point of view, but mechanically it is excellent, as there are no crossings. This winding might be well adapted to motors, especially in the case of the three-phase, on account of its weakly defined dead points. The manner of connecting the coils can be readily traced.

A uni-coil winding having overlapping coils is shown in Figs. 3 and 4, where there are the same number of coils per pole piece per phase as in the previous diagrams, but half the coils are straight and half bent the straight coils overlapping the bent ones. In the quarter-phase winding the two circuits are brought out independently to four collector rings, which is the usual practice, although the two phases could be interlinked and only three rings used, one of them being common to both phases.

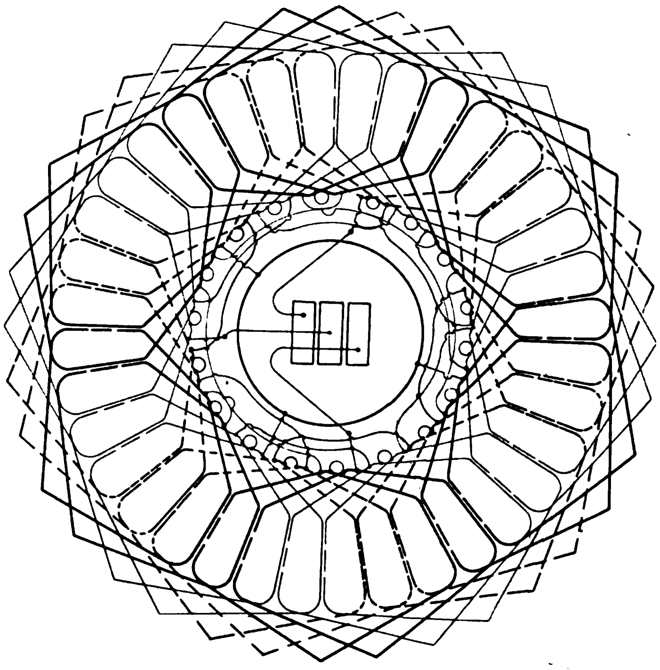


FIG. 11.—THREE-PHASE DRUM WINDING, HAVING TWO SLOTS PER POLE PER PHASE.

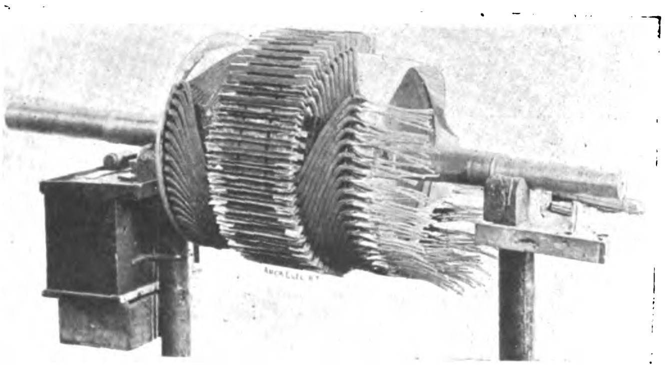


FIG. 10.—DRUM WOUND ARMATURE PARTLY WOUND.

The three-phase winding is shown Y connected, that is, one end of each of the three phases is connected together, the other three going to collector rings. The coil connections can be readily traced from the diagrams.

This is, perhaps, the best polyphase winding for a uni-tooth construction, having one coil per pole piece per phase.

MULTI-COIL WINDING.

Figs. 5 and 6 show an overlapping winding similar to the preceding, but having two coils per pole piece per phase. The quarter-phase winding (Fig. 6) is similar to the preceding three-phase winding, which shows an armature having the same number of coils, but connected three-phase. From this it seems that the three-phase winding shown in Fig. 3 could be used for a quarter-phase winding in a field having two-thirds the number of poles by changing the coil connections; similarly, the three-phase winding shown in Fig. 5 could be used as a quarter-phase winding in a field having six poles by changing the pole connections so that all the straight coils are connected for one phase and all the bent coils for the other phase.

It may be noticed from these and from the preceding diagrams that the three-phase winding has twice as many coils in a group, i. e., the straight coils overlap twice as many bent coils in the three-phase winding as they do in the corresponding quarter-phase winding, which might make it appear as though there were more coils per pole piece per phase in the case of the three-phase winding than there were in the corresponding quarter-phase winding. This is due to the fact that the straight coils have to span over the coils in the remaining phases, so that in the quarter-phase winding there is only one remaining phase to be crossed, while in the three-phase winding there are two, thus making twice the number of coils. This also makes possible the using of the same armature as a three-phase or quarter-phase by changing the number of poles.

As the end connections from coil to coil, as shown in the diagrams, become somewhat complex and indistinct when there is more than one coil or group of conductors per pole piece per phase, the winding diagrams corresponding to Figs. 5 and 6 are **shown in Figs. 7 and 8, where the connec**tions can be more readily followed, the bent coils being shown by full and the straight coils by dotted lines.

This winding and the uni-coil winding are the best adapted to high voltages. The insulation on the coils being of a necessity very thick, it is advantageous to make the winding in as few coils as possible. For this reason the uni-coil winding would have the advantage, but when better regulation and less armature reaction are desired, for long-distance transmission work, the winding is best arranged in two coils per pole piece per phase, as shown in Figs. 5 and 6.

If a still further distribution of winding is desired, it can be carried out on the same plan as that shown in Figs. 5 and 6, but in the case of the quarter-phase winding, if the number of slots per pole piece per phase is an odd number, it will make **an uneven distribution and arrangement of** the coils, making the winding unsymmetrical; hence, it is usual to adopt another style of winding when there are more than two slots per pole piece per phase.

In the case of the three-phase winding the same style of winding can be used as shown in Fig. 5 by putting three or more coils together and the winding will still remain symmetrical, but if more than three coils are used in a group the end connections become very long, thus making the copper losses high. It also requires a large number of different sized coils, which is a disadvantage, as it makes necessary a multiplicity of winding forms.

Hence, where there are more than two coils per pole per phase in the case of the quarter-phase and the coils for the three-phase, a drum winding is usually used.

In a drum winding all the coils are alike, and, as the coils must cross each other on the ends of the armature, it is necessary to make them interlock in some manner. This can be done in a number of ways, but is perhaps best accomplished by making one-half or side of a coil in one plane and raising the other side to another plane, as shown in Fig. 9.

In this manner it is possible to make all the coils symmetrical. From this it will be seen that all one side of a coil will occupy the bottom and the other side, or half, the top of a slot; therefore, in order that all the slots may be entirely filled, two coils are put in each slot.

The coils are laid in the slots one after another around the armature, as shown in Fig. 10, until the winding is completed, the connecting being done after all the coils are in place. To facilitate connecting the leads are brought out of the coil at one end close together, as shown in Figs. 9 and 10.

The connections for a six-pole three-phase winding of this description are shown in Fig. 11. For simplicity, a winding is shown having only two coils per pole piece per phase, the coils being drawn in heavy lines, one side of a coil being in the bottom of a slot under one pole (shown by a dotted line in diagram), and the other side in the top of another slot in the corresponding position under an adjacent pole.

A winding of this type can be made for any number of coils per pole piece per phase, the connections being similar, but having a greater number of elements per group.

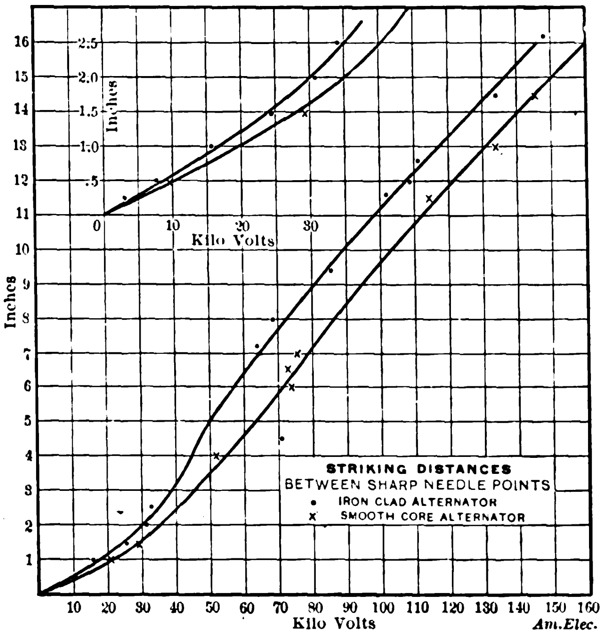
* * *

CURVES OF DISRUPTIVE DISHARGE.

In the accompanying figure is an interesting little chart containing valuable information on the subject of high-voltage discharges, the more so because Mr. Charles P. Steinmetz, who is a well known authority on such subjects, is responsible both for the curves and the statements concerning them. The experiments of which these curves are a record were made with powerful discharges generated by powerful alternators.

Two curves are shown here, with striking distances for ordinates and kilovolts for abscissæ. The upper curves are the results of experiments made using as a source of power a modern toothed alternator armature, and the lower curves were similarly obtained using one of the old style smooth body armatures with pancake coils. The striking distances were accurately measured, the terminals being fine sewing needles. It was found necessary to renew these needle points at every experiment, as the action of the discharge vaporized the points and made subsequent results incorrect.

Between balls, plates and rounded conductors the striking distance is very nearly the same for voltages above 100,000, but it is very much less for low voltages, striking only across ⅛ in. between balls of 1 in. or so in diameter. The melted needle points produced this ball effect, and hence the necessity for their renewal with every discharge. The discharge between needle points is much more reliable for fairly low voltage than that between balls, and therefore needle points are preferably used. Temperature, moisture, etc., seem to have no noticeable effect on the striking distances between sharp points, which at a given voltage is very closely the same under all conditions.



CURVES OF DISRUPTIVE DISCHARGE.

* * *

WHAT IS GOOD PRACTICE IN ARMATURE MAGNETIZATION?

Every dynamo engineer has his own ideas on almost every point in the design of a machine, but on no point do they differ more widely or adhere more stubbornly to their own ideas than on the question as to what is the best density to use in the magnetization of an armature. An examination of the various machines in practice and, it may, be added, good practice, discloses the fact that armature densities varying from 40,000 to 90,000 lines to the sq. in. are considered as suitable by various designers. The school of high density is essentially of English extraction, while machines of low armature induction are mostly American designs.

The high density advocates argue that their practice renders a smaller armature permissible and improves commutation, and that the added reluctance that the contracted area inserts in the magnetic circuit is a negligible amount. The low density engineers hold that the employment of a high induction entails a very careful selection of iron or the loss by hysterisis will become so great as to overheat the armature, and further that the low density armature is inherently larger, affording a greater radiating surface and rendering a much larger copper loss permissible. In this way the machine may be made to carry large overloads. Moreover, they state that the art of designing windings that will commutate satisfactorily is so far advanced that it is no longer necessary to overpower the armature with the field magnet.

Both are right, but the desirable features of the one practice may often be profitably sacrificed to secure the advantages of the other. The strength of the induction, therefore, depends more on the conditions that are to be met in the design. If, for example, slow speed is desired above all else, there is no escape from high density. If, on the other hand, overload capacity is desired, high density is to be avoided. It is not to be inferred that a machine in which the armature is highly magnetized is of light weight, for as a usual thing little is gained in this direction by such a practice. The diminished area of the air gap will increase the reluctance and the leakage in sufficient measure to demand a field magnet and exciting coils of added weight. A ring armature which is inherently larger than a drum armature of equal output may work at a higher density, for it does not suffer as seriously by a diminished air gap. The necessity of carefully selecting the iron to be used in armatures to work at high densities is by no means imaginary. Iron, or rather steel, for all modern sheet iron is such, is frequently so highly susceptible to hysterisis losses that if incorporated into a core, it would heat dangerously when in operation from hysterisis alone. Indeed, of two armatures made of different iron but otherwise identical, one will often burn out and the other show itself capable of carrying heavy overloads. The difficulty, if not the impossibility, of uniformly procuring good iron is certainly a temptation to lower the induction. The consensus of modern opinion seems to be that density is somewhat like speed; it may be increased above a certain limit to gain other advantages, but as a general rule the density cannot be increased over 50,000 lines to the sq. in. without serious sacrifice.

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THE INDUCTION MOTOR.

III.—INDUCTION MOTOR FIELD WINDING.

By ALFRED E. WIENER.

The winding frequently called the field or primary winding which produces the rotary field of an induction motor consists of two or three coils, respectively, subdivided into sections and placed around the field-core in such a manner as to form a number of magnet poles on the inner periphery of the stator when traversed by electric currents. Figs. 1 and 2 are diagrams of two-coil windings (for bi-phase currents), the former being connected up in ring-fashion, having the turns completed in the form of spirals around the external periphery of the magnet-core, and the latter in drum-fashion, having all the connections upon the end faces of the field-frame. In Figs. 3 and 4 the respective developments of these windings are shown, from which can be seen that the direction of the current in the conductors near the inner periphery of the magnet-frame is the same in both windings. For the sake of simplicity both windings are arranged so as to form but four greater number of poles, simply being formed by a repetition of the connections shown, can readily be derived from the illustrations given.

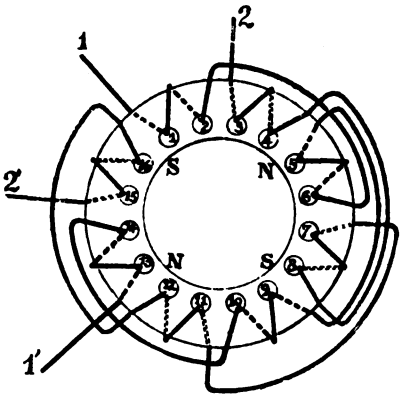


FIG. 1.—TWO-PHASE FIELD RING WINDING FOR INDUCTION MOTOR.

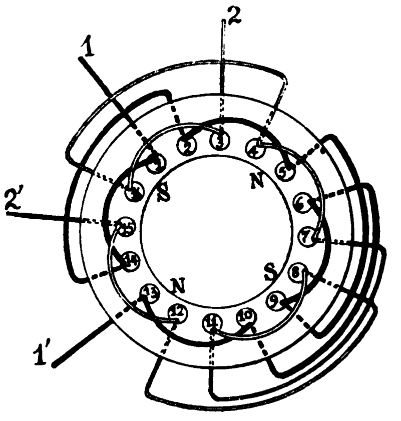


FIG. 2.—TWO-PHASE FIELD DRUM WINDING FOR INDUCTION MOTOR.

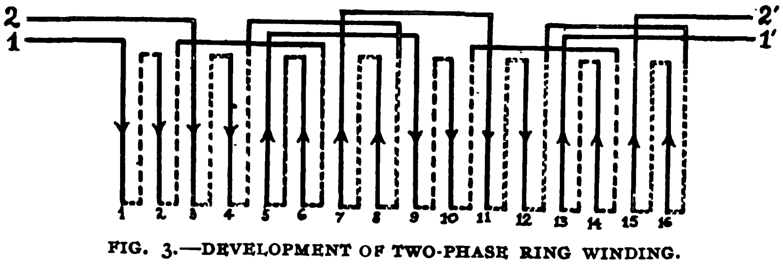


FIG. 3.—DEVELOPMENT OF TWO-PHASE RING WINDING.

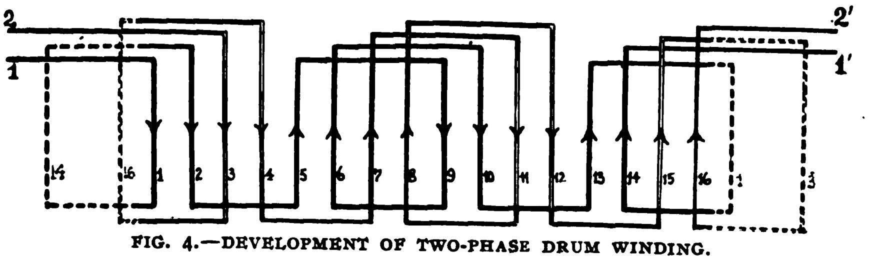


FIG. 4.—DEVELOPMENT OF TWO-PHASE DRUM WINDING.

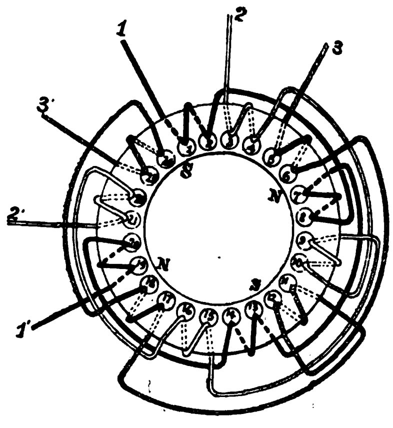


FIG. 5.—THREE-PHASE FIELD RING WINDING FOR INDUCTION MOTOR.

In Figs. 5 and 6 the corresponding three-coil windings (for three-phase currents) are illustrated, the former being a diagram of a three-phase ring-winding, the latter that of a three-phase drum winding. Fig. 7 is the development of Fig. 5, and Fig. 8 the development of Fig. 6. In the windings represented by Figs. 1 to 8 only one conductor per slot is taken for simplicity, Fig. 9, therefore, is added to show how the field-winding will have to be executed if, as is usual in practice, there are a number of conductors in every slot, three conductors per slot being chosen for illustration.

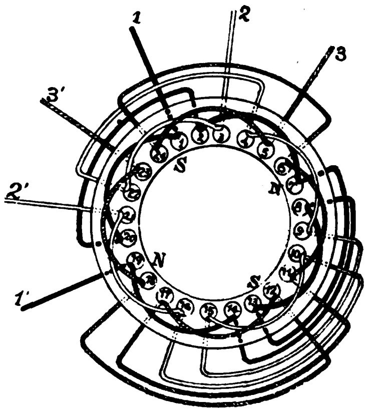


FIG. 6.—THREE-PHASE FIELD DRUM WINDING FOR INDUCTION MOTOR.

To supply the field-coils of a two-phase motor there generally are needed four line wires, one for each of the terminals, 1, 1', 2, 2' (Figs. 1 to 4); in case of a three-phase motor, however, since the algebraical sum of the currents in three-phase systems is always zero (see Fig. 21, page 194), the three coils can be connected in such manner that only three line wires are required, a fact in which lies one great advantage of the three-phase over the two-phase motor. If the two coils of a two-phase winding are not connected in the form of a closed circuit but are independently wound, two terminals of different phases may be joined together to a single return wire. In this case, however, the reduction of the number of line-wires does not constitute a saving in copper, as, on the contrary, the weight of the line for the same maximum voltage then is about 45 per cent in excess of the four-wire line arrangement.

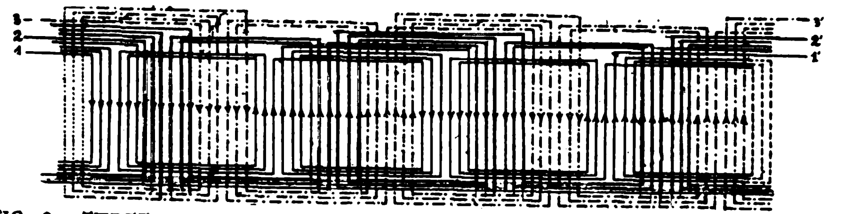


FIG. 9.—THREE-PHASE DRUM WINDING HAVING THREE CONDUCTORS PER SLOT.

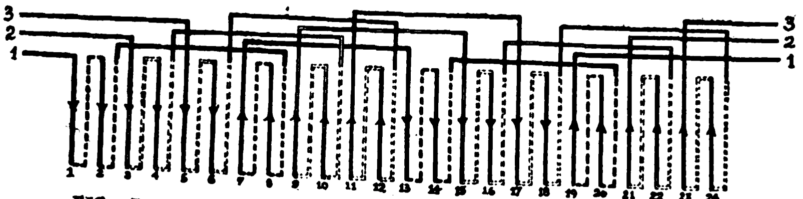


FIG. 7.—DEVELOPMENT OF THREE-PHASE RING WINDING.

For the relative weight of copper in the various systems of electrical distribution Messrs. Edgecomb and Fox, in a recent paper read before the London Institution of Electrical Engineers, give the following figures:

System.	Relative weight of copper for given maximum voltage.
Direct current	100
Single-phase	200
Two-phase, 4 wires	200
Two-phase, 3 wires	291
Three-phase	150

There are two methods of connecting the field-coils of a three-phase motor, (1) the mesh, or Δ (delta) connection, and (2) the star, or Y connection. The former consists in joining the three coils in series with each other and connecting the line wires to their junctions, as indicated diagrammatically in Fig. 10; while in the latter the three coils are joined in parallel, one end of each being connected to a common point and the free ends to the three line wires, see Fig. 11. The difference, electrically, between these two connections is shown in Figs. 12 and 13, which give the distribution of the line potential E and current I in the Δ- and Y windings, respectively. It will be seen that in the Δ-winding, since there is but one coil between each two line wires, the potential in each coil (that is, the potential per phase) is equal to the line potential; and that in the Y-winding two coils of 120 deg. phase-difference are in series, from line to line, hence the voltage per phase—the base of a 120-deg. isosceles triangle being 2 sin 60 deg. = $\sqrt{3}$ times one of its equal sides—is $\frac{E}{\sqrt{3}} = .577$ E. For the same reasons the maximum current per phase in a mesh-connected field is $\frac{I}{\sqrt{3}} = .577$ I, and in a star-connected field is I, or equal to the line-current, while the corresponding currents in the two remaining coils in each case are one-half the respective maximum value (see Fig. 21, page 194).

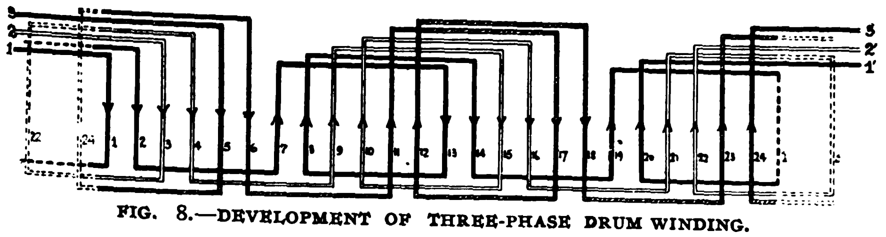
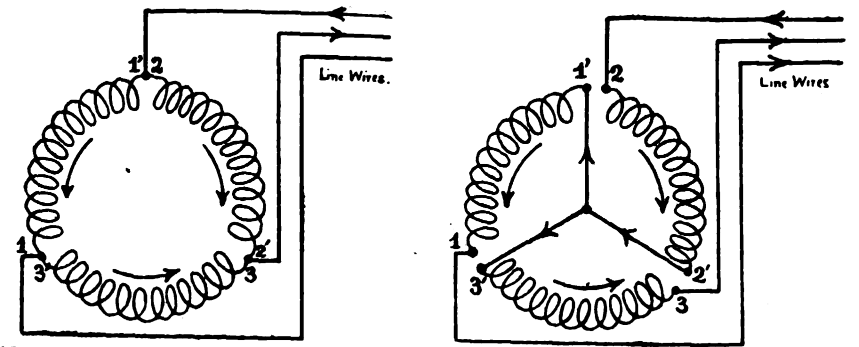
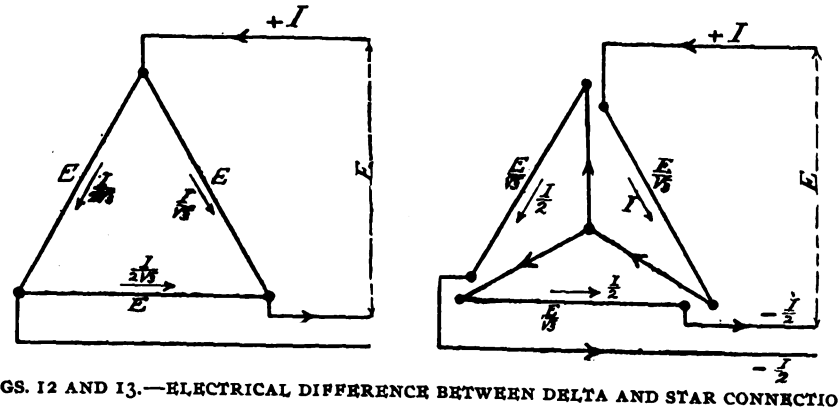


FIG. 8.—DEVELOPMENT OF THREE-PHASE DRUM WINDING.



FIGS. 10 AND 11.—DIAGRAMS OF DELTA AND STAR CONNECTIONS FOR THREE-PHASE INDUCTION-MOTOR.

Any three-phase winding may be connected up in the Δ or in the Y form, but, as can be derived from the above, the Δ-winding will give $\sqrt{3} = 1.732$ times the current, but only $\frac{I}{\sqrt{3}} = .577$ of the voltage of the Y winding, and vice versa: and to supply a Δ-connected three-phase motor it will, therefore, take 1.732 times the current and .577 of the voltage required for a Y-connected motor.



FIGS. 12 AND 13.—ELECTRICAL DIFFERENCE BETWEEN DELTA AND STAR CONNECTIONS.

ACCURACY IN WIRE FORMULAE.

The ill-advised pains which many electricians and mechanicians take to measure certain quantities, the results of which are to be incorporated with other considerations of doubtful accuracy into calculation, is surprising. A result which is calculated from numerous data by means of simple factorial methods is no more accurate than the accuracy of the least accurate measurement of the component qualities. An example which is of every-day occurrence may be cited. In the calculation of wire, formulæ are devised in which the specific resistance of copper is conscientiously quoted from Matheissen's tables, and after the wire has been calculated the nearest standard size is chosen, even though it differ several per cent from the true result, for the reason that it would not pay to draw special wire for such a case. The measurement of linear distances by means of a clothesline with a micrometer attachment is scarcely less absurd than some of this fantastic effort to obtain accuracy in a result which is ultimately approximated.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Aluminum Dynamo Brushes.—According to "L'Elettricitá" aluminum has many advantages as a material for dynamo brushes. While its resistance is higher than that of copper, it is about 100 times lower than that of carbon, and the metal is to a certain degree non-arcing. For the collection of high tension current of small volume from commutators it has many advantages over copper. Used on the rings of alternating current dynamos, aluminum brushes are said to have given most excellent and satisfactory results.

New Battery Fluid—According to the "Revue Independante des Sciences Médicales, Pharmaceutiques et Veterinaires," a new liquid, called "calcide" by its inventor, Dr. Busse, of Hanover, has been brought out as an excitant for primary batteries. It consists of oxychloride of calcium dissolved in a solution of sal ammoniac. These two substances are easily obtained and are cheap. The liquid is said to possess high conductivity and not to freeze above —22 degrees Fahrenheit. Excellent reports of its value as an excitant are given.

Snow on Overhead Wires.—Some interesting figures concerning the weight of snow which can be borne under some conditions by wires are given in "La Nouvelle Gazette de Zurich." The specific gravity of wet snow was found by the meteorological station at Zurich to be 0.02, and a wire 630 ft. long was found to have carried 120 lbs. of snow, or forty times its own weight. It is not stated whether this wire was supported at various points, but as its gauge was only about 18 B. & S., it is supposed that it was. Some poles exposed to this storm carried as many as 250 wires, and it is by no means remarkable that they were broken.

Plating Aluminum.—A durable method of plating aluminum goods, according to the "Practical Engineer," is the Wegner process, in which the article to be plated is first pickled in a bath composed of oxide of iron, acetate of copper, sulphur and chloride of alumina dissolved in vinegar. After taking out of the bath it is brushed with a soft wire brush. A metallic coat then develops on the surface of the aluminum, closing its pores and rendering it perfectly smooth. After washing in clean water, the article is plated in a bath in the usual way.

Electricity on Belgian Railroads.—The Belgian Government, which controls the railways in its territory, has asked for bids for the electrical equipment of the line from Mons to Boussu, a distance of about 6 miles, this, according to the "Moniteur des Chemins de Fer," being the first section of an installation that is to be greatly extended. A central station of great size and thoroughly modern is to be built, and the whole work is to be completed within twenty-five weeks from its commencement. Cars similar to those used on the Charleroi and Centre lines will be used, about $50,000 being set aside for the rolling stock.

Calcium Carbide from Basic Slag.—A new method of extracting phosphorus and calcium carbide from basic slag has been brought out in Germany, says the "Practical Engineer." Tricalcium phosphate is mixed with an excess of powdered coke and heated in the electric furnace, whereby calcium carbide, phosphorus and carbonic oxide are formed. The phosphorus passes over into a condenser and is recovered, the yield being said to be about 80 per cent of the total present in the mixture. Some experiments have also been made toward converting the phosphates in these slags into phosphides to serve as deoxidizing material for overblown iron. The results, however, were negative.

Glass Conductors.—According to the electromagnetic theory of light, all conductors except electrolytes should be opaque to light. If, therefore, under certain conditions glass becomes conducting, the conduction must be, as an approximation, regarded as electrolytic. In "Electra" (Amsterdam) A. Vosmaer describes a striking illustration of the conductivity of glass. Two electrodes terminating in glass rods are connected to the terminals of a high-tension transformer. Nothing happens while the glass rods are cold, but if they are heated by a Bunsen burner they become conductors, and an arc strikes between them. The heat of the arc is sufficient to keep up the conductivity of the glass.

A Huge Electrical Scheme.—A bill embodying a scheme of electrical development of power of ultra-American magnitude is now being considered by a committee of the House of Lords, says the "Practical Engineer." The bill empowers a corporation to supply electricity for lighting, traction, power and other purposes over a district of about 2000 square miles, including the towns of Sheffield, Lincoln, Nottingham and others. The central generating station is to be at Worksop, in the midst of a coal mining district, where coal slack may be had for about 50 cents per ton, and the promoters expect to be able to supply electrical energy to a large market at an extremely low rate.

A Long Land Line.—The Canadian Pacific Railway Company is now building a land line of copper wire from Montreal to Vancouver, which will contain, when completed, no less than 2900 miles of copper wire. Some interesting practical tests on insulators for this line have been going on recently at McGill University, and are described in the "Canadian Engineer." The tests are for the resistance to fracture of various types of glass and porcelain insulators, the result being that the porcelain resisted much heavier and more blows than the glass. With a 32-calibre revolver fired from a distance of 8 ft. the glass insulators flew to pieces at nearly every shot, while the porcelain frequently showed no mark except a blackening from the lead of the bullet; when they did break it was generally in such a way that, had they been attached to the pole, the wire would not have fallen. The wire used on this line weighs 300 pounds per mile, and shows a conductivity of 97 per cent.

Aging Transformer Iron.—Mr. R. C. Clinker, in a letter to "The Electrician," confirms Roget's researches on the aging of transformer iron. During a period of two years he made a series of tests on different brands of iron, and noticed that at a certain temperature the iron commences to improve after having been "aged." As an example, he quotes the case of a sample of Swedish iron which showed the very low initial hysteresis loss of 0.15 watts per pound at 2500 lines per sq. centimeter and 100 cycles per second. After twenty-six days at a temperature of 90 degs. C. the hysteresis loss had gone up to 0.31 watts per pound. The sample was then put in an oven at a temperature of 120 degs. and after seven days showed a loss of only 0.19 watts per pound. In other samples the same effect was found, but in less degree. Another specimen of iron started at 0.31 watts, and rose in five days, at a temperature of only 90 degs. to 1.07 watts per pound, after which it slowly improved.

Melloni Piles.—Dr. H. Rubens discusses in "Zeitschrift für Instrumentenkunde" the value of the thermopile for investigations of minute temperature changes. This instrument has lately been supplanted by the bolometer of Langley, Boys' radiomicrometer and the sensitive photo-electric pile of Minchin, but the author thinks that the thermopile may be made more efficient than any of these by properly reducing its thermic capacity. Antimony and bismuth, while showing a high thermal e.m.f. are mechanically weak and unsuited to the construction of such apparatus. He proposes to substitute iron and the nickel-iron allov called "constantin" in the form of very fine wires. The thermoelectric power of the iron-constantan couple is only about half that of the bismuth-antimony combination, but the gain in sensitiveness due to the diminished size and thermic capacity of the apparatus more than compensates for the difference. Dr. Rubens has lately constructed such a thermopile having twenty couples, its resistance being 3.5 ohms and its e.m.f. 0.000106 volt per deg. Centigrade. This instrument he regards as marking an important advance in radiometry.

Nickel Plating on Wood—To successfully nickel plate wood it must first be coated with a thin layer of metal. "Le Génie Civil" gives the following formulæ: Prepare three solutions: (1) 1½ grammes of pure gum rubber dissolved in 10 grammes of carbon bisulphide, to which is added 4 grammes of melted wax. In another vessel make a mixture of 5 grammes of phosphorus, 5 grammes spirits turpentine, 4 grammes asphalt powder and 60 grammes carbon bisulphide, and add this to the first solution while stirring. (2) Make a solution of 2 grammes of nitrate of silver in 600 grammes of water. (3) A solution of 10 grammes of chloride of gold in 600 grammes of water. Place the object to be nickeled, with the conducting wires in place, in solution No. 1 and dry well after taking out. Then pour the second solution over it until it takes a dark metallic appearance. Rinse off with water and apply the third solution in the same way. Through this treatment the wood takes on a yellowish color and is now fully prepared for nickel plating. The bath for plating should consist of 500 grammes of ammonium nickel sulphate, 50 grammes of ammonium sulphate and 10 litres of water. The liquid must be neutral, which may be arrived at by the addition of ammonia chloride solution until litmus paper is unaffected.

Electric Painting.—Under this title "L'Eclairage Electrique" contains an article by M. P. Marcillac, describing a system of protecting vaults, rooms, etc., against burglars. It consists of a coat of conducting paint, which is furnished at a convenient point with a connector. This is laid on and dried, then varnished with an insulating varnish. On the top of this is put another coat of the conducting paint, also furnished with an appropriate terminal, and over all is put the usual veneering, papering, paint or other surface finish. By connecting a battery and bell to the two layers of paint a signal is sounded as soon as any attempt is made to penetrate the paints with any metallic instrument. Another use for this paint is in the compartments of vessels, which may be thus painted in stripes at definite distances below the water-line. In case of a leak the sea water completes the circuit and shows on an annunciator the location and depth of the entering water. Still another use is found for the paint as a covering for long-range targets, an annunciator showing where the bullet has made contact between the conducting layers. The ingenuity and simplicity of this system of alarms are probably greater than its utility.

Heating Switchboards.—In a paper read by Mr. J. R. Blaikie before the (English) Municipal Electrical Association on Switchboard Apparatus, he made the curious suggestion that the place for the field rheostat is on the switchboard, because it keeps the latter warm, and thus prevents the disastrous effects of condensation of steam and fog. The placing of such rheostats on the lower panel of the switchboard is so general in this country, that there has been little opportunity to see what effects might follow their removal and the consequent cooling of the board, but it is certain that there is a distinct element of danger in a switchboard colder than the surrounding air, especially in high tension work. The film of moisture that will certainly form on it under these circumstances may lead to disastrous results, but it is not likely that it will persist, as the passage through it of any considerable current will electrolyze and dissipate it, at the same time locally heating the board. Still, the point is a good one, and is worthy of attention. Another suggestion of Mr. Blaikie's is that switches, etc., should be given a coat of some of the various paints that change color when heated, this being a safe and simple indication of local trouble.

Cost of Electric Cooking.—A manufacturer at Frankfort has been trying some pleasant experiments upon the cost of electric cooking, which are described in "Elektrotechnischer Anzeiger." Luncheons for four or six persons were prepared by a restaurant cook, the current being supplied by the local electric light company at 3.75 cents per k.w. hour. A specimen bill of fare is as follows:

	Amps. current.	Minutes.	Cost.	
Cooking 3 pounds of beef....	8.7	20	1.186	cents.
Keeping beef warm..........	2.6	154	2.75	"
Parboiling 1 cauliflower.....	8 8	22	1 33	"
Baking the cauliflower......	8.8	20	1.21	"
Egg-sauce for cauliflower....	0.6	1	0.04	"
Keeping above warm........	3 1	14	0.29	"
Broiling 4 cutlets....	5.5	10	0.43	"
Heated pan too soon (wasted)	5.5	5	0.19	"
Frying potatoes in butter...	5.	25	0.86	"
Total cost of current for cooking luncheon for four........................			8 29	cents

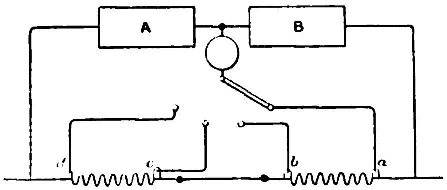
An excellent luncheon for six, including a steak, fish with tomato sauce, potatoes and rice à la condé was cooked at a cost for current of only 6.91 cents. To heat water for washing the dishes and utensils the cost is given as 1.75 cents for 2.5 gallons. A quart of coffee can be made for 0.5 cent. The cost to a family of four for three ordinary meals is calculated to be about 11 to 12.5 cents per day.

Power from Blast Furnace Gases.—Great interest is being manifested in Europe in the power than can be obtained from the generally wasted gases of blast furnaces. Great advantages are gained by utilizing these gases in gas engines rather than by burning them under boilers. The "Revue de Mécanique" sums up the discussion of this matter, and quotes the following figures: The calorific power of these gases is about 1000 calorics per cubic metre, and they produce when burned under boilers about 1 pound of steam per cubic metre (35 cubic ft.). It thus requires about 800 cubic ft. of gas per h.p.-hour by this method as against about 100 cubic ft. required for developing the same power with a good gas engine, the latter developing a capacity of about 2000 h.p.-hours for each ton of pig iron produced by the furnace. At Seraing (Belgium) an Otto engine of 200 h.p. has been installed. The gas goes through three coke scrubbers and is washed by a spray of water before going to the engine. After washing it contains about 1 grain of impalpable dust to the cubic foot, but this is said not to have any harmful effect, the washing being sufficient to remove any acids that might injure the cylinder. Two blast furnaces, making 1600 tons of Bessemer pig per week with a consumption of 9.75 tons of coke per hour, will give, after deducting the 1000 h.p. necessary for the blast and the gas used in heating the air, 10,780 h.p. effective for use. This assumes the employment of gas engines, which show for this work a superiority of 450 per cent over steam engines using the same gas as fuel.

Comparison of Very Low Resistances.—"L'Industrie Electrique" gives the following method of comparing very low resistances, due to Messrs. A. E. Muller and Hermann Wallau: Referring to the illustration, let R be a standard resistance and x the resistance to be compared. Current is allowed to flow through these low resistances in series, and they are provided with the terminals a, b, c and d. The resistance coils A and B, connected in series and shunted around the two resistances to be compared, are each of about 10,000 ohms, one of them having all its plugs in, the other none. A galvanometer of great sensitiveness is connected, as shown, between the junctions of the coils A and B, and each of the four terminals of the resistances to be compared. For each position of the switch the resistance of the two coils A and B is varied, so that their sum remains constant at, say, 10,000 ohms, and until the galvanometer stands at zero. If the resistances cut in in coil A for the four positions of the switch be called a, b, c and d, corresponding to the connections of the switch with the terminals thus lettered, the value of x is given by the formula:

$$x = \frac{a - b}{c - d} R$$

While this method is slower than that of the double Thomson bridge, it is simpler with the apparatus usually found in laboratories. The main current should, of course, be kept rigorously constant throughout the experiment. By using an alternating current and a telephone the same method may be applied to the measurement of the internal resistance of an accumulator.



LOW RESISTANCE MEASUREMENT.

A Rival for the Electric Furnace.—In a rather rhetorical article in "L'Industrie Electrique," M. Georges Claude discusses the possibilities arising from the manufacture of oxygen by the Linde process. This process, as is well known, consists of the liquefaction of air, the oxygen content of the mixture being least volatile evaporating last, so that liquid oxygen or highly oxygenized air may be obtained by the partial evaporation of the liquid. The author states that by this process it is possible to produce more than 185 cubic ft. of oxygen per h-p.-hour, and thus the oxygen may be had for the insignificant sum of 5.4 cents per 1000 cubic ft. The possibility of obtaining very high temperatures by combustion in pure oxygen is well known, and the author avers that he has made calcium carbide by the combustion of a mixture of lime and coke dust in this gas. He goes on to argue that this method, being cheaper than the electric furnace method of producing high heats, will displace the latter for all work where electrolytic action is not required at the same time. As the air is simply a mixture of nitrogen and oxygen, the energy required for their separation is almost *nil*, but in practice, owing to losses of various sorts, it amounts to a respectable figure. Notwithstanding, M. Claude is convinced that carbide will be made in future through the agency of the oxygen of liquid air—a sort of paradox in which the lowest attainable temperature is employed as a step toward producing the greatest possible heat.

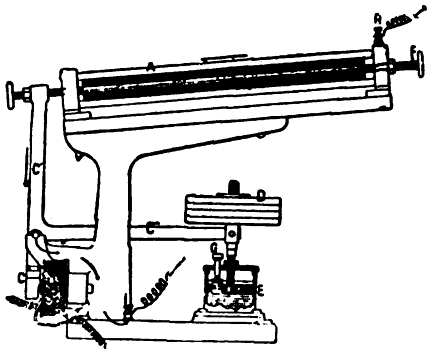
A Regenerative Electro-Zincing Process.—The (London) "Electrical Review" gives a short account of an interesting electro-galvanizing process due to Mr. Cowper-Coles. It appears that the chief difficulty hitherto encountered in processes of this character have been due to the fact that neither cast nor rolled zinc electrodes dissolve in a proper way to keep the electrolyte in good working order. Mr. Cowper-Coles obviates this by the use of zinc dust or "tultz," which is a grayish amorphous substance obtained as a sublimate in the flues of zinc smelting furnaces. It contains about 97 per cent of metallic zinc, and is not to be confused with the oxide of that metal. This dust is placed in regenerative tanks in the shape of a mixture with fine coke or sand on grids so placed as to form a filter bed. The solution used is allowed to circulate through these tanks so that any free acid is neutralized. If the zinc dust is allowed to get into the electrolyte it is found to increase its electrical resistance. A zinc sulphate solution containing 12.6 per cent of free acid, after passing through such a filter bed containing 10 per cent of zinc dust was found to hold only .7 per cent of free acid. These filters not only serve to keep the solution up to its full strength, but also to rid it of impurities in suspension, which are a cause of spongy deposit. The best electrolyte is composed of 40 ounces of zinc sulphate to the gallon of water, and has a specific gravity of 1.177. Lead anodes are used, the current density being 17 amps. per sq. ft. and the e.m.f. being 6 volts.

Electricity and Agriculture.—Dr. C. Kottgen, a well-known German savant, has just made an elaborate report upon the possibilities of electricity in agricultural operations, which is briefly summarized in the "Practical Engineer." He concludes that, sooner or later, the use of electric power in agriculture is sure to come, but that electrotechnics must first make many advances. Electrical machinery has in its favor that it is light and easily transported, and perfectly adaptable to the application of power over an extended area, while the most favorable conditions for the use of electric power are when water power is available or the waste product from some other industry can be had for steam raising. Electric motors, while better adapted to plowing than to any other farm operation, are still useful in threshing, feed-cutting, grinding, irrigation, drainage and for other uses. Experiments have shown the technical possibility of the application of electricity for these purposes, but its economical use on farms smaller than 600 acres is very questionable.

All this is especially interesting when it is considered that the straw from an ordinary Dakota wheat farm is generally burned to get rid of it, and that it possesses sufficient potential power to move all the machinery of the farm. Notwithstanding the rather faint praise of the German engineer, there seems to be an opportunity for considerable development of electrical machinery for farm purposes, especially where these are conducted on a gigantic scale, as in our own Western States and the sugar plantations of Cuba.

Electric Rock Drill.—In the iron mines at Bindt, Austria, an installation of electric percussion drills has been set to work, and "Zeitschrift für Elektrotechnik" gives some interesting data of its performance, omitting, however, to give the most important figures—the speed of the hammers. The apparatus for drilling consists of two solenoids mounted in an iron tube and alternately attracting an iron armature mounted on the piston of the machine. Current is furnished by a special alternating dynamo, and there are no commutators or switches about the apparatus. A system of spiral feathers and clutches allows the piston of the drill to strike out straight when the blow is delivered against the rock and turns the drills and piston the proper amount on the back stroke. The machine, after setting in position, can be advanced 2 ft. by a screw, thus boring to this depth without resetting. The cylinder, containing all the working parts, is 34 ins. long, 5 ins. in diameter, and weighs only 160 pounds, being the lightest of all percussion drill apparatus. Its capacity is for holes between 1 and 2 ins. in diameter. A table of the speeds of drilling through various materials is given by our German contemporary, but neither the diameter of the holes nor the number of strokes per minute are stated. From this it appears that the speed in very hard siderite iron ore is 15.6 ins. in ten minutes, and for the same length of time is 18.3 ins. in fairly hard ore, 18.6 ins. in quartzite schist, 21.4 ins. in hard schist, and over 30 ins. in soft schist.

Automatic Carbon Rheostat.—A very ingenious and simple self-regulating rheostat, adaptable to a great variety of uses, has been designed by M. J. Ferrand and described in "L'Electricien." Its operation will be readily understood by reference to the accompanying figure, which shows the apparatus in section. The resistance consists of a pile of carbon discs, A, which are held in place by four glass tubes forming a cage about them. At one end of the pile is a regulating screw, F, which bears upon a bronze end plate. At the other end of the pile of discs the end plate rests upon a screw attached to the extremity of the lever C. The tension upon the pile of discs is regulated by the action of the counterpoise D and the electromagnet B, a dashpot E being provided to avoid too rapid and sudden movements of the lever. By properly connecting this machine and varying the counterpoise, it may be made to accurately regulate the amount of current flowing through it, or the difference of potential at the extremities of the carbon resistance. In the latter case, of course the coil B is of high resistance and shunted around the carbon, while in the former case it is of low resistance and connected in series with the regulating discs. It is said that by the use of this rheostat the designer has been able to hold the terminal potential of a 10-kw. machine constant while the speed varied between 1000 and 2000 r.p.m. Its principal use is expected to be found in connection with field regulation for dynamos, as its automatic qualities are especially valuable for this purpose.



AUTOMATIC RHEOSTATS.

Nerve Currents.—In a communication to the Royal Society, Messrs. F. Gotch and G. J. Burch describe their investigations of the electrical responses of nerves to a single stimulus, which they have observed with a capillary electrometer. The stimulus employed was a relatively feeble induced current caused by the opening of the primary circuit of an induction coil, to which was attached one cell of battery. In all the experiments the sciatic nerves of large frogs were used. The stimulus was applied to the sciatic plexus about an inch from the nearest of the electrometer contacts. The shock traveled along the nerve past a pair of unpolarizable contacts connected with the electrometer, and was in each case immediately followed by the nerve current in rapid succession. Photographic records were taken, the exciting current showing on them, but being readily distinguishable from the larger following nerve currents. Some of these nerves used were freshly prepared, while some had been kept in cold salty solution for twenty-four to ninety hours. The two sets of nerves showed marked differences. In the fresh ones the first indication of the presence of the reaction occurs 0.002 second after the stimulation. The decline commences 0.001 second after that. In the nerves that were kept the loss of vitality showed both in the initial change and the rate of propagation. The latter falls from 10 or 15 to about 6 metres per second. The actual e.m.f. of the nerve currents may be put as high as 0.032 volt, which is a suggestive fact in view of the various theories of the electrical organs of fishes.

An Alternating Current Watt-Hour Meter.—A novel and interesting form of watt-hour meter for alternating currents is described in the (London) "Electrical Review." The illustrations show the meter in plan and cross section. The field is of a four-pole type, each pole having an extension on one side and all these extensions pointing the same way. The series coil is wound on Gramme fashion, while the shunt coil is in two semi-circular parts on frames, each part surrounding two of the field poles. The core of the armature, shown at E, is stationary, the revolving part being a copper bell, G, Fig. 1. To the shaft of this is attached a copper disc running between damping magnets. The whole of the moving part weighs less than 2 ounces, and has its weight further decreased by the upward repulsive action of the field. An external inductive resistance, which can be adjusted, is used, so that the scale can be read directly in k.w.-hours without the use of a constant. The torque due to the shunt field alone is a little more than sufficient to compensate for friction in the apparatus, so that the moving parts would constantly revolve at a very slow speed. This tendency is counteracted by a small piece of iron wire adapted to be caught in the field of one of the permanent damper magnets, so that the meter does not move, even if violently shaken, with no current in the series coil. The slightest current in this coil, however, is said to start the meter, which will register at ½ per cent of its full load. Obviously such a meter, while free from commutators and sliding contacts, has to be adjusted to the frequency at which it is to be used. A second non-inductive resistance in shunt with the shunt coil is used to regulate the lag of phase in the meter.

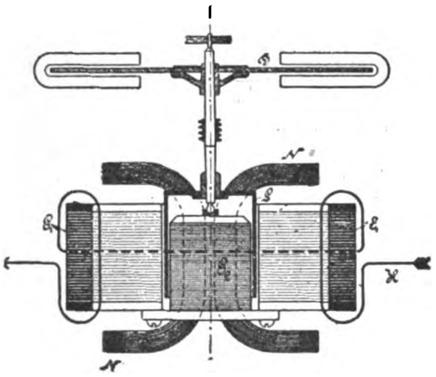


FIG. 1.—SECTION OF ALTERNATING CURRENT WATT-HOUR METER.

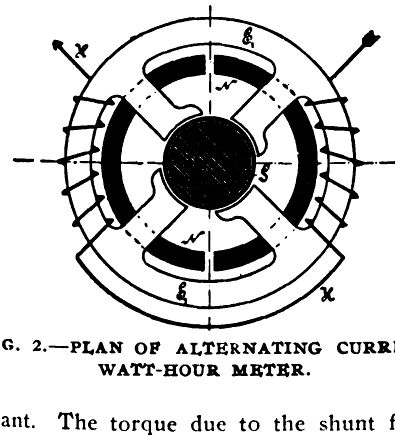


FIG. 2.—PLAN OF ALTERNATING CURRENT WATT-HOUR METER.

Electrical Resistance of Steel.—M. H. Le Chatelier has contributed to the Académie des Sciences the results of a series of experiments on the electrical resistance of steels of various composition, and the conclusions that he draws concerning the effect of various constituents.

The effect of carbon is to increase the resistance per cubic centimeter about 7 michroms for each additional per cent of carbon. Silicon produces an augmentation of about 14 michroms for each per cent added (by weight) or 7 michroms for each atom of silicon to 100 atoms of the alloy. The author concludes that the silicon is not isolated in the steel as the definite compound Fe Si$_2$, but is distributed through it in a homogeneous mixture. Manganese increases the resistance very considerably. While this metal forms isomorphous mixtures with iron in all proportions these alloys show two allotropic states in which the magnetic qualities are widely different, the conducting qualities also differing. In the 13 per cent manganese alloy the resistance, in the magnetic condition, was found to be 66 microhms and in the non-magnetic state 80 microhms per cubic centimetre. Nickel shows the same double properties, its iron alloys having two magnetic as well as two conductive states. The variations due to the presence of carbon, silicon and other ingredients, however, cause the resistance of these specimens to be very uncertain. Chromium, tungsten and molybdenum have a very small effect upon the resistance of steel. The author thinks that the small influence of these metals on the resistance shows that they are isolated in the metal as definite combinations, and not distributed through it.

Producing High Temperatures with Aluminum.—At the recent annual meeting of the Deutsche Elektrochemische Verein a paper was read by Dr. Goldschmidt, describing an interesting method for producing very high temperatures by the combustion of aluminum through the aid of the oxygen combined in an oxide such as that of iron. The mixture of powdered aluminum and the oxide is lighted with a match and burns quietly. In a furnace made of an ordinary wooden bucket lined with sand a large iron rivet weighing 6.6 pounds was readily heated to a white heat. The cost of the process is said to be very small, as very little aluminum is consumed. The method is especially well adapted for hard soldering and brazing. One of the principal uses of the process will be to obtain certain metals in a pure state free from carbon. Chromium can be easily obtained in this way in the free state. Another use is the uniform and powerful heating of particular parts of metallic objects. It suffices to surround the part to be heated with powdered aluminum and a cheap and fairly refractory oxide, such as iron oxide or silica, and to kindle the mass by a fuse or charge of a mixture of aluminum powder and an easily reducible oxide. The temperature resulting can be adjusted with precision by varying the proportions of the mixture and the size of the charge. It is thought that this process may become a formidable rival to electric welding.

The process is really a secondary method of applying the heat of the electric furnace, for the heat set free is that absorbed in the reduction of the metal during its manufacture. A point of great practical importance is that commercially impure aluminum answers the purposes of this process, a high content of iron being no detriment.

Diaphragms for Electrolysis of Alkaline Chlorides.—A very interesting description of the various diaphragms used in electrolytic alkali processes is contributed to "L'Industrie Electrochemique" by M. H. Becker. The difficulty of obtaining good diaphragms is one of the greatest in connection with these processes, and the success of several of the best known has been through their suppression of this auxiliary. The qualities necessary are low electrical resistance, sufficient lack of porosity to prevent the mixture of the solutions on the two sides, and slow deterioration in the presence of caustic alkalis and chlorine. Among the oldest types are the paper parchment diaphragms of Le Sueur and others. These parchment septa have also been utilized in connection with a protecting layer of a chloride of one of the alkaline earth metals. Rieckmann has used diaphragms made of albuminized paper and of pure albumen, the latter being prepared by flowing a solution of blood albumen between two plates of oiled glass and heating it to the coagulating point. The glass is easily stripped away from the albumen film. Hoepfner uses paper covered with collodion, which becomes sufficiently porous after soaking in water for some time. Porcelain and porous clay have been often proposed, but do not seem to have met with much favor in practice. Many attempts to use asbestos or some of its products have been made, one due to Roberts and McGraw being to subject a sheet of asbestos pulp to the action of hydrochloric acid for twenty-four hours, after which it is washed and rolled under heavy pressure. An English process makes use of a perforated sheet of metal, which is covered with a paste of lime and asbestos, dried and washed with a solution of silicate or phosphate of soda. These diaphragms can also be used as cathodes, but for this purpose the covering of the metallic sheet should be sufficiently strong and porous to resist the action of the hydrogen evolved. Wiernick prepares diaphragms by superposing layers of asbestos and kaolin or asbestos saturated with soda silicate solution, the whole being rolled. Waite makes porous plates by the use of bichromated gelatine and asbestos, the gelatine being "fixed" by exposure to sunlight. A similar process in which the bichromate is replaced by formic aldehyde is in use by Rieckmann. Numerous other methods of using asbestos alone or in combination have been tried. Portland cement has also been used in the manufacture of diaphragms, a British patent describing the addition of salt, which is dissolved out after the cement has set. Coke, sand, powdered pumice stone, ravelings of linen and chopped hair are also mixed with the cement to increase its porosity, the organic substances dissolving out under the action of the electrolyte.

Central Stations in Spain.— Dr. Arthur Lietke, of Madrid, writes for "Elektrotechnische Zeitschrift" an interesting article on the electric lighting industry in Spain. There appears to be no genuine electrical industry in that country, the business being in the hands of foreigners, principally Germans. At the middle of last year there were 300 central stations in Spain, which, as that country has about one-third the population of Germany, indicates that the electric light is used there to a considerably greater degree than in the more progressive Empire. About 90 per cent of these stations are in small cities and towns. In nine of the forty-eight provinces there is no town of 4000 inhabitants or over not provided with a station. These towns were not generally provided with gas plants, and the high price of petroleum oils has assisted the progress of the electric light. About 60 per cent of the installations are driven by water power. While franchises are easily obtained, they are not ever exclusive, and there is much competition, there being five stations in Madrid, and from two to three each in Barcelona, Seville, Malaga, Valencia, Saragossa, Bilbao and Cordova.

It is difficult to obtain accurate data of these stations, as may be imagined from the general character of the inhabitants. About 48,000 h.p. is used for dynamo driving, or about 30,000 k.w. in round numbers. This is about one-half as much as is devoted to the same purpose in Germany, but considering the difference in population indicates that there is a greater use of electric light per inhabitant in Spain. Of this power about 35,000 h.p. is generated by steam and about 13,000 by water power. Gas engines and steam turbines are very little used. Of the small stations about one-half the number use water power, but the average power developed is only 70 h.p.

A number of statistical figures are given. Direct current is used in only 40 per cent of the stations, but supplies 70 per cent of the total light. Accumulators are used in only 5 per cent of the stations, most of which are operated only from dark until midnight. As much as 95 per cent of the wiring is overhead, but few poles are used, the wires being attached to the fronts and roofs of houses. This feature of Spanish installations was commented upon in one of these notes in the June number. Dr. Lietke makes the remarkable statement that in Spain is found the greatest proportion of electric street lighting to population in the world.

The installation cost for one of the little 70-h.p. stations generally falls between 100 to 200 pesetas per 10-c.p. lamp (a peseta at par is equal to a franc, about 20 cents, but is now at a large discount). The charge for lighting is about 3 pesetas per month from the water power stations and 4 pesetas from the steam stations for a 10-c.p. lamp. It is not stated whether these figures include renewals. In the southern provinces the mass left after the extraction of the oil from olives is used as fuel, and it is said that an economy of about 40 per cent over coal firing is thus obtained. The average price of coal is 35 pesetas ($7) per ton.

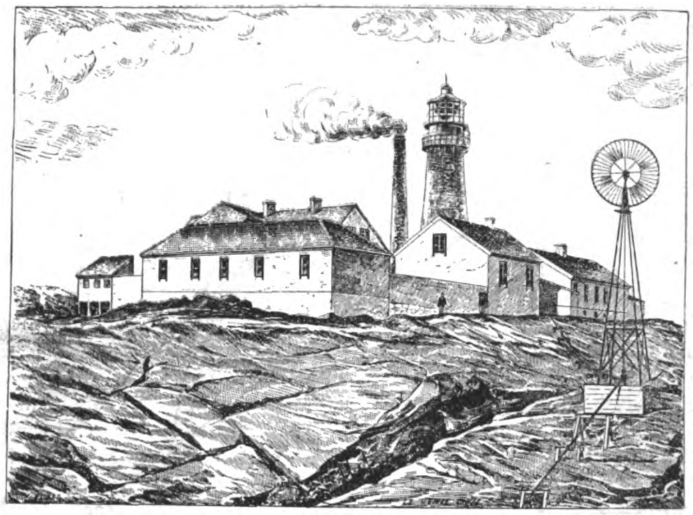


FIG. 1.—ELECTRIC LIGHTHOUSE AT RYVINGEN, NORWAY.

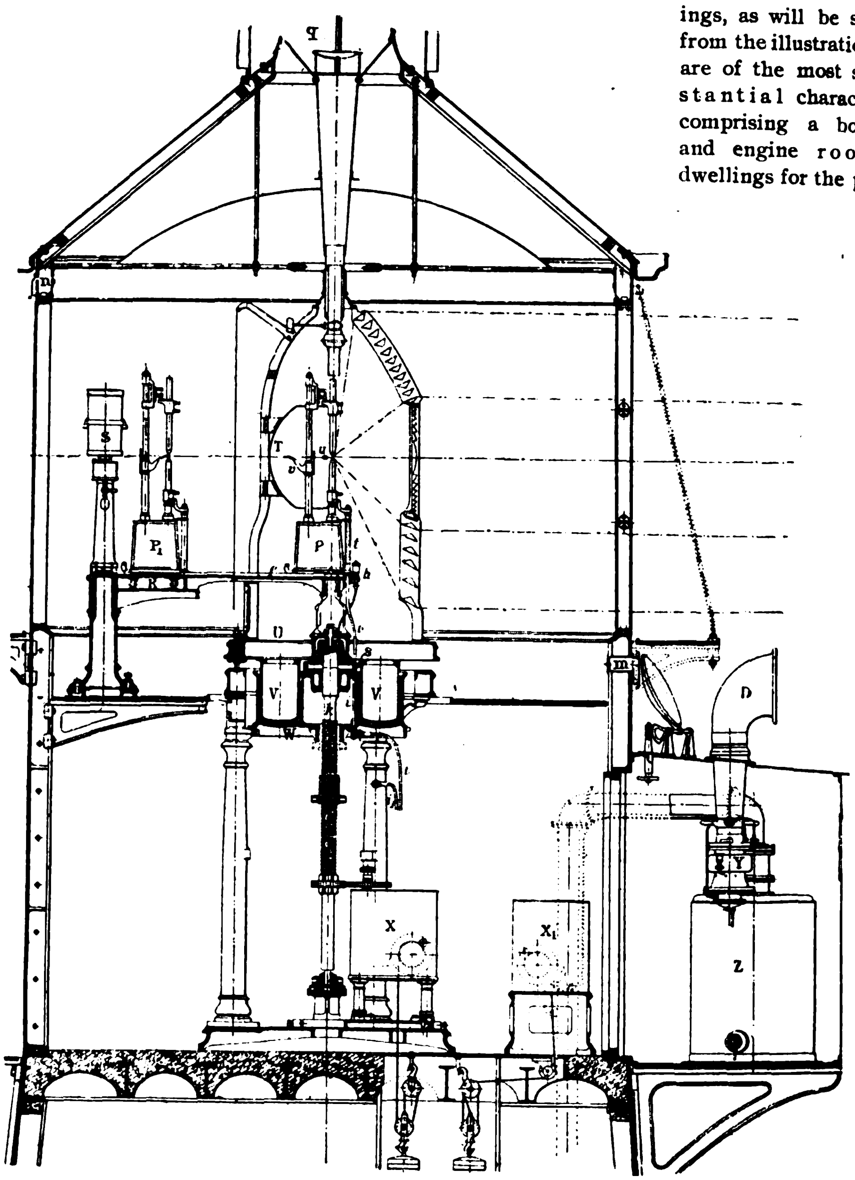


FIG. 2.—LANTERN OF ELECTRIC LIGHTHOUSE.

A Norwegian Electric Lighthouse.—An electric lighthouse of the "flashlight" type has been erected at Ryvingen, on the coast of Norway, and is described at great length in "Le Génie Civil." The principal points points of interest in this lighthouse are the electric generators and the lamps, both of which are of a type so ancient as to appear novel. The buildings, as will be seen from the illustrations, are of the most substantial character, comprising a boiler and engine room, dwellings for the personnel of the establishment, coal sheds, etc. Fresh water is collected in a pool in the rocks near the light, the rainfall being abundant, and pumped by a windmill to a tank under the boiler house. Rainwater from the roofs is also collected and stored for the use of employees. The tower carrying the light is built of 1-in. cast iron plates, and is about 70 ft. high, its base being about 100 ft. above the sea level.

In the boiler house are two Babcock & Wilcox boilers of 400 sq. ft. heating surface each, and working at 120 lbs. pressure. There are two high-speed automatic engines of 25-h.p. each, working at 220 r.p.m. A mixture of gas-coke and Welsh coal is used to avoid smoke. One engine and boiler are sufficient to furnish power both for the light and the fog siren, so that there is an ample reserve of power.

The generators are Meritens magneto machines, the fields being composed of permanent magnets. Each of the two machines has five sets of magnets, each set containing eight radial bundles of magnets, eight magnets of horseshoe form, 18 ins. long and made of steel plate ⅜ by 2 ins. to the bundle. There are thus 320 of these magnets to each machine. The armature cylinder is 17 ins. in diameter. Each machine gives 110 amps. at 45 volts and 60 cycles per second. In addition to these magnetos there is a very small 110-volt dynamo for lighting the engine room and tower stairs. Three arc lamps are provided for the lantern. Each is arranged to consume 50, 100 or 200 amps. at 45 volts, using carbons of ⅝, 1 or 1⅛ ins., respectively, with a corresponding candle power of 5000, 10,000 and 20,000. The lamps are of the Serrin clockwork focussing type. On account of the heat generated, these lamps cannot work over one hour continuously on the heaviest current, or over four hours at the lowest consumption, and they have to be shifted by hand when they become too hot for service. A turntable, shown in the illustration of the lantern, has a reserve lamp arranged for service upon it, and the change can be made in about 15 seconds. An oil lamp, shown at S, is also kept in reserve to provide against the failure of the electrical apparatus. The flashes from the lantern, which is turned by clockwork and floats on mercury, are sent out 2½ seconds apart until four are given, then a period of eclipse of 12 seconds is succeeded by four more flashes, and so on. With the largest carbons and heaviest current the intensity of a flash (in the meaningless units employed for this sort of photometry) is stated to be 34,312,500 c.p.

It is interesting to see the Meritens machine revived after more than twenty years of well-earned repose. Why clockwork is used to turn the lantern when alternating current is on hand in abundance, and why vertical feed lamps are used, are questions that are not answered by our contemporary.

Lithanode Accumulators.—In a long illustrated description of the process of manufacturing what are called "Lithanode" accumulators the (English) "Electrical Review" describes a method of making cakes or pellets of lead peroxide which will not disintegrate. It is simply by mixing litharge with a solution of sulphate of ammonia, which causes the litharge to harden and "set" like a cement. These pellets are then formed in the usual electrolytic way, but in the original process forming was conducted in a bath of sulphate of magnesia.

Aluminum Brass.—About 1 per cent of aluminum in brass, according to the "Mechanical World," is extensively used for electrical purposes, as this metal casts free from pinholes, and the addition of the aluminum gives a greater strength than the brass would otherwise show. From this it follows that a cheaper grade of brass can often be made to do the work of a higher priced grade by the addition of aluminum. In cases where the best results are desired it is very important that the ingredients of the brass shall be pure, as the nature of some of the impurities commonly contained in copper and zinc are such as to absolutely prevent the production of good alloys with aluminum. For aluminum alloys the metals should not contain more than ¼ per cent of iron, arsenic or antimony, or more than 0.02 per cent of bismuth.

Some Water Power Station Tricks.

To the Editor of American Electrician:

In at least one case where water and steam are coupled together for driving a generator there are several things the attendant has to look out for. One of these is the speed of the water wheel which drives the generator. The case is this: The generator which supplies the lines is in a building in town, while the water wheel, which does a good share of the work, is two or three miles distant.

Current is generated there at 110 volts and transformed up to 2000 two-phase alternating, and thus sent to town where a synchronous motor receives it and transforms the energy into rotative form again. The amount of power derived from the wheel is not enough, and neither is it steady enough to be used alone for driving a unit. Therefore the motor is belted direct to the wheel of a steam engine, and from the wheel on the other side of the engine a belt leads direct to the generator which feeds the lines. The water wheel governor keeps the speed at practically its proper value.

There are, however, times when things do not go well with the water wheel. When water is low, and the generator is loaded heavily, the governor does not work as well as would be desired. When the water is low and it is necessary to run at almost half gate, there must be some regulation at the main station, or the load put on the water wheel will cause the governor to work the gate wide open, even when it is set at half gate. Therefore constant watching of the instruments and adjustment of the gate regulator is necessary.

It is not that the governor is not a good one, for it is—it is one of the very best in the market—a pneumatic governor, and a very sensitive one, too. While the load is below a certain amount the governor will take care of it if there is water enough to give the regulator full swing. But with low water, when the speed drops by the load being more than half gate can carry, the synchronism of the generator and the motor is destroyed, and the water wheel does hardly any work until the governor is "doctored a little" and more water given for a few minutes.

Another thing with this plant is that it cannot be shut down at will, without causing trouble somewhere on the line. It would naturally seem as if, were the water wheels shut down—there are two of them geared to the same shaft—that the engine at the power house would have to work all the harder to make up for so much extra power which the wheel formerly supplied. This in a measure is so, but it does not work at all in the manner which would be expected. It does overload the engine at the power house, but that machine is powerful enough to carry the extra work and goes right along without even a hesitation.

But the motor which is connected with the steam engine, instead of continuing to be a motor after the speed of the generator which drives it falls below a certain speed, becomes a generator, and transmits current back to the water wheel station sufficient to run all the machinery, consisting of the two water wheels, the generator, transformer, several hundred feet of shafting in the water wheel station which is connected thereto for the purpose of driving other machinery.

All this machinery will be driven by the engine at the city power house, provided that the water is shut off gradually, and the speed of the machinery allowed to decrease gradually. Should, however, the water wheels be shut down quickly, the motor at the power house will respond with such a rush of current that one or more of the fuses will blow and cut off connection between the machines.

There is one more pecularity which I have noted in connection with this installation, and that is that when water is scarce, and both wheels have to be throttled down to about half gate, and when the load in the spool shop is also considerable, there will be periods when the generator at the water power station and the motor at the power house are both acting as generators, and seem to be running one against the other. The instruments indicate that very little current is being sent to the power house, while at the same time the wheels are both running, but are evidently driving nothing but themselves, as is evident from their excessive backlash, which will prove destructive to the wooden cogs if permitted to continue.

It is evident that during these periods of "neutral activity" the plant, or at least the generator, should be stopped, and the water allowed to accumulate until there is enough to do more work. The steam engine is getting no help under those circumstances.

JAMES F. HOBART.

Brooklyn, N. Y.

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Railway Feeders and Ground Returns.

The necessity for a good ground return is so widely and thoroughly appreciated by railway managers that it has created and supported a number of well-to-do supply companies, who make bonding their specialty. It is interesting, however, to note the significance of property distributing the copper between the overhead and underground circuits, and it is frequently the case that in a given line the same copper differently distributed could effect a substantial reduction in line losses.

Consider, for instance, a concrete case in which a certain feeder delivers 500 amps. at a certain point 5000 ft. from the station with a loss of 50 volts. Its resistance is, therefore, one-tenth of an ohm. If the return circuit have the same resistance, the total resistance would, of course, be two-tenths of an ohm, which is the smallest possible value that the amount of conducting material used can afford. If, for example, we increase the size of a feeder by 50 per cent and correspondingly diminish the conductivity of the ground return, it is evident that the resistances would be, line one-fifteenth of an ohm, return one-fifth of an ohm. Thus the return would have a resistance equal to the entire original line, constructed from the same conducting metal on the equal resistance plan, and the total resistance would be greater the further the deviation from the condition of equality.

The power lost is inversely proportional to the resistance of the line, and this is, therefore, a most serious consideration. Curiously enough, many railway systems attempt to reduce their line losses by increasing their insulated copper, when the rail return, if more heavily bonded, would produce the same results at a fraction of the expense. In not a few cases the laws of maximum economy have been so grossly violated that better results could be obtained by disconnecting several feeders and tapping them into the rails at intervals, thus utilizing them to improve the ground return. Frequently this has been done where managers have had the feeders and have not had the money to pay for the necessary bonds. As a means for making the best of the mistake in the expenditure of money it is commendable, but as a practice in initial installation it is unpardonable.

If bonding were as expensive as insulated copper with poles, it is obvious that the condition of equal conductivity should prevail, but such is not the case; the bonding is cheaper. It follows, therefore, that for maximum economy the resistance of the rail return should be less than that of the corresponding feeders, and the difference, of course, is dependent on the relative costs of feeders and bonds. Unfortunately for the easy mathematical determination of the problem, the cost of the bonds is not a simple function of the conductivity they add to the ground return, as is the case of feeders. It makes a pretty problem in maxima and minima, but it should at least be approximately solved by anyone who has to lay out a feeder system, even if nothing more refined than the rule of thumb is at his disposal.

The Candle-Power Rating of Electric Lamps.

The great pains and ingenuity which various eminent associations and institutes have expended in estimating the value of old standards of light and estimating new ones has been and will continue to be ill-advised unless more care is taken in the commercial use of such units. The photometer is indeed used, and perhaps accurately, but the choice of results upon which rates are based and the relative merits of lamps determined is more absurd than the measurement of the area of a piece of land by its frontage or the performance of a dynamo by its electrical efficiency.

The error consists in taking the c.p. measured in one direction or plane as a measure of the c.p. of the lamp. The commercial measure should be the mean spherical c.p., for in practice the lamp is expected to give light not only from its sides, but from the crown and lower parts of the base. Indeed, in many cases, the useful illumination comes largely from those areas. It is evident at once that the ingenious lamp manufacturer may so dispose his filaments as to give a large c.p. in a plane parallel to the axis of the lamp, while the other parts suffer, and such a lamp, if tested in one direction, may easily show a greater efficiency in watts per candle than a lamp of greater mean spherical c.p. taking the same electrical energy. It is not to be inferred from this that a lamp of large horizontal c.p. is not advisable or desirable, but to rate its efficiency upon that function is wrong, and the practice infinitely wrong.

It cannot be alleged that this is an evil that does not exist. It may easily be that electrical engineers and lamp manufacturers scrupulously measure and accurately know the mean spherical c.p. of the lamps they test, but the fact remains that many sales to-day are decided upon the results obtained by the use of photometers measuring the c.p. only in one direction. Such photometers are cheaper and more easily improvised, and hence more plentiful. Moreover, the measure of the mean spherical c.p. is a tedious process and requires careful manipulation, even if the means are at hand. Such a state of affairs creates a keen competition in the arrangement of filaments in bulbs rather than in the production of filaments burning for many hours at high temperature.

In the case of an arc lamp the absurdity is so patent that it deceives no one. The old device of adding together the north, south, east and west c.p. to make up a total of 2000 or 1200 in lamps whose maximum c.p. in any direction does not exceed 800 or 500, amuses more persons than it misleads, but, strangely enough, it does not seem to set them to thinking about their incandescent lamps and the way they are awarding their contracts.

The case is one involving the tedious tack of educating the public, and as long as there remains an element to be educated, gold bricks will be bought and the vendor of goods who gives them the best external appearance will prosper and flourish, whether it be the humble Italian polishing his apples on a trousers leg or the ingenious twister of filaments. It is further evident that until the single position determination of candle power is no longer used as a criterion of efficiency that the simple standard candle is amply sufficient for commercial purposes .

Transformers in Series.

In another column is an article on the construction of a transformer by the use of simple materials. The information which it affords will be of undoubted value both to the experimenter and the student, for large currents of low voltage and small currents of high voltage are very frequently desired and, as the writer has pointed out, the utility of the instrument is very sweeping. For the production of very high voltages the writer recommends a number of transformers connected in series with the primaries, presumably connected in parallel. It may be added that as a precautionary measure it is very important that transformers to be used for such a purpose have a very heavy insulation between primary and secondary; in fact, sufficientlv thick to withstand the total voltage of the system. A moment's reflection will show the necessity of this. The extreme secondaries are immediately adjacent to a practically common mass of metal, the primary, and the total insulation between them consists of but two thicknesses of the separating insulation between primary and secondary. Not a few experimenters have connected together a number of station transformers for the purpose of producing high voltage and discovered this fact at the expense of disabling one or more of the transformers.

The Calcium Carbide Industry.

In another page is described an extensive and particularly well equipped plant for the manufacture of calcium carbide; and while the electrical enthusiast may congratulate himself on the ultimate installation of 40,000 h.p. of the most modern electrical machinery, there is room for reflection in the purpose to which this apparatus is to be put. The argument certainly is that the calcium carbide industry is a profitable one and that acetylene is beginning to be used as an illuminant, for otherwise it would be hard to justify the installation of a plant of more than double the capacity of the extensive carbide works at Niagara, and, moreover, involving a much greater first cost, than its consort on the lower lakes.

It behooves us, therefore, to improve the efficiency and economy of the electric lamp and produce more light for less current. There is no question but that the electric light has a long lead on acetylene. As an illuminant it is doubtful if acetylene would ever produce a better light, even though it might produce a less expensive one. But we have no right to assume that trouble in the management of the carbide or danger from explosions will be its commercial death blow. The pioneer days of the electric light saw quite as many formidable objections, which ingenuity has overcome. We cannot expect less of our competitors. Acetylene as it is at present can never hope to rival the electric light, but acetylene as it may be is likely to make the race interesting, if electrical inventors deceive themselves with the idea that in the field of illumination we have attained perfection.

Modern Alternator Design.

The field magnets of most modern alternators revolve, and their construction has been varied by many makers, and we may soon expect to see designers settle down to preferred types in much the same way that direct current engineers have universally adopted the drum armature and the internal radial pole. At present, alternator field magnet construction, that is to say, those of the rotating class, seem to be divided between single coil branch circuit affairs, inductor dynamos and magnets involving many salient poles, each carrying a coil.

The feature of no moving wire, which obtains in the inductor dynamos, is certainly, on first sight, a most attractive advantage, but it is too often secured at the expense of the design and the efficiency of the machine, and it is questionable whether it is not more of a trade-talking point than a real advantage. Such machines almost invariably involve a concentric coil of large internal diameter. If this coil is not to move it must be secured rigidly in position about the revolving core, and a sufficient clearance must be provided between them. To be mechanically secure it must be mounted on a heavy spool. Comparing this construction with the device of winding the concentric coil directly on a revolving core on a moderately thin spool, the advantage of the lesser mean length of turn at once obtains, and, almost invariably in such a case the pole pieces of the machine can be much more advantageously disposed and the general accessibility improved. Inasmuch as a coil wound concentrically to the shaft is in an ideal position to be secure from the strains of centrifugal force, and as in good designs the current supplied to such a coil is very small and requires only two collector rings of moderate size, it becomes an open question whether the stationary coil is such a decided advantage after all. The brushes of such collector rings are independent of angular position. If they make moderately good contact, they can never spark or give trouble. The voltage of the moving system is low and not liable to pierce the insulation. It is not surprising, therefore, that many makers have preferred to abandon the idea of the inductor machine and wind the concentric coil directly on the moving member.

In order to be efficient, the polar projections of such a construction as this must be suitably mortised and tipped with laminated plates, and in very large machines such a gigantic coil is difficult to wind, and, should it be disabled, it would involve a serious delay before it could be repaired. These disadvantages and others have undoubtedly induced many makers to adopt the multicoil field in large machines. The subdivision of the coils is a decided advantage as regards repair, although their mechanical arrangement is not as good as in the case of a single concentric coil. The labor expended on fitting the pole pieces is no greater than in the case of a single coil machine of equal efficiency, and the leakage factor is said to be considerably less, for the concentric coils surround and heavily magnetize the shaft, which frequently finds a circuit through the frame; indeed, many makers have found it necessary to provide massive brass bearings for their frames in order to break the continuity of this serious shunt on their magnetic circuits. We have yet to see very large alternate current machinery built on the single coil plan, and it will be decidedly interesting to note just what form American designers will finally decide to standardize.

A HOME-MADE TRANSFORMER.

The occasion often arises for the employment of a transformer in the test room or laboratory, and frequently for one constructed with some unusual ratio of transformation. The design here illustrated is for a small transformer which can easily be made by a student or experimenter for his own use, it requiring no machine work whatever, though a winding lathe or some substitute for one is a great help in its construction.

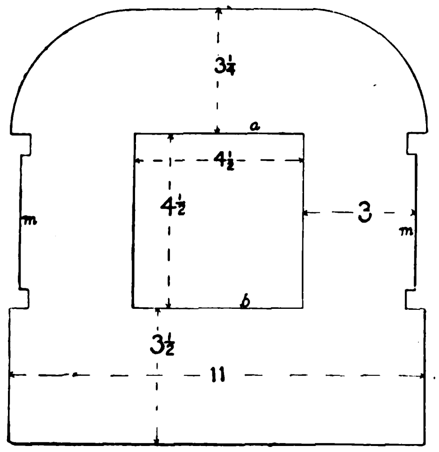


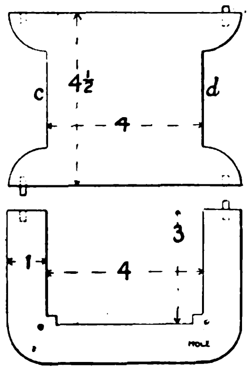
FIG. 1.—END BOARD OF IRON WIRE SPOOL.

The frame of the transformer is made of hard wood boards, ½ in. thick, 12-in. stock being required. The field iron consists of a square coil of No. 18 soft iron wire, upon which the copper wire current-carrying coils are wound. To make the frame, cut out of the board two pieces, as shown in Fig. 1, these being the heads of the spool upon which the iron wire is wound. Two other pieces, shown in Fig. 2, are nailed or screwed to these at the points a and b (Fig. 1) so as to hold them separated at a distance of 3 ins. apart, inside to inside. The frame thus constructed is a sort of spool having two vacant sides, the square hole shown in the center of Fig. 1 being the axis of the spool. After it is assembled the edges c and d of the piece shown in Fig. 2 should be protected with strips of sheet iron or brass bent to a square corner and tacked on, as otherwise when the iron wire is wound on it will cut into these corners and make a rough and unmanageable coil. A wooden mandrel, 3½ by 4½ ins., should now be made and driven into the hole through the spool to hold it securely while the iron wire is being wound.

The iron wire should be of the softest obtainable quality, free from kinks and in long lengths. No. 18 is the best size, but smaller wire will answer excellently, though somewhat more expensive and troublesome to wind. The winding of this iron wire is by all odds the hardest part of the work of making the transformer, as it should be neatly done and care should be taken to avoid kinks or unevenness in the lay of the wire. A good plan is to bore a small hole through the side of the spool (the part shown in Fig. 2) as close as possible to the head, and start the end of the iron wire in this. Wind the first layer under very strong tension and as evenly as possible. The tension can be relaxed a little after the first two or three layers are on. A carpenter's handscrew with pieces of leather glued to its jaws makes an excellent clamp for holding the wire and regulating its tension while winding.

Each third or fourth layer should be well painted with black asphalt varnish, used very thick. If the wire breaks or if it is necessary to splice it, solder down the end to the coil with a drop of soft solder and start the next end as close thereto as possible, also soldering it fast to the coil. This iron wire must be wound 3 ins. deep, or until it stands flush with the edges of the heads at the points mm, Fig. 1.

The pieces shown in Fig. 3 are the heads for the coils of copper wire, four of them being required. These are provided with dowels, as shown, arranged to engage with the ends of the pieces of Fig. 2, with which they have the relation shown in the illustration. These heads fit in the notches shown in the edges of Fig. 1, small projections ¼ in. each way being left for this purpose, as shown in Fig. 3. When these pieces are in place the core of the transformer is ready for its windings.



FIGS. 2 AND 3.—HEADS FOR COPPER-WIRE WINDINGS.

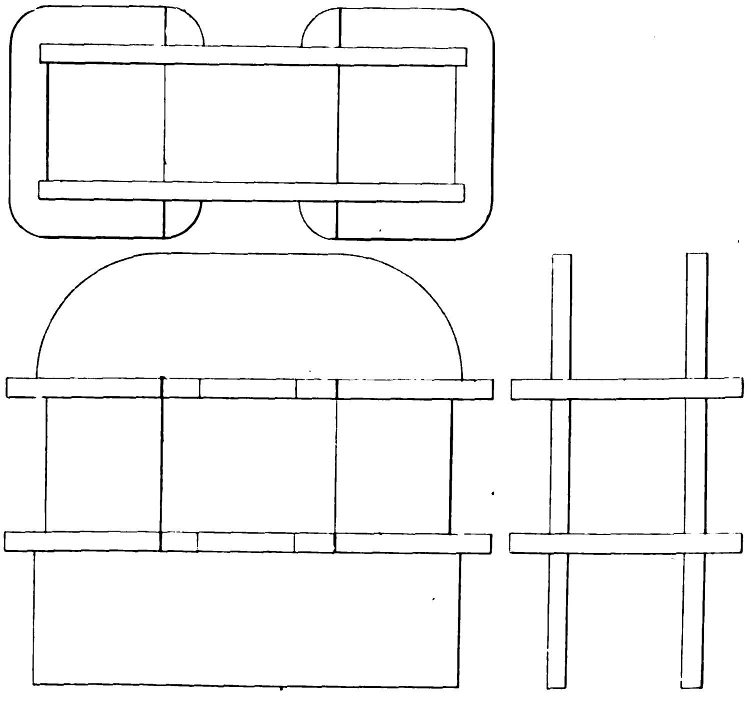


FIG. 4.—PLAN, SIDE AND EDGE ELEVATIONS OF COMPLETE WOODEN FRAME.

In the bottom of the space for each coil a piece of cotton cloth should be wrapped around the leg of the iron wire coil, and shellacked down to keep the winding away from the iron wire of the core. Holes about ⅛ in. in diameter should be drilled in the corners of the pieces, Fig. 3, as shown, for the terminal wires of the coils. The view of the finished machine, Fig. 6, shows how the ends of the primary and secondary coils are brought out and attached to binding posts on a board at the top of the whole.

The winding naturally depends upon the transformation ratio required and the frequency. That given below is for 55 or 110 volts on one side and 550 or 1100 on the other, at the ordinary frequencies of 7000 to 16,000 cycles per minute. It is not safe to use higher voltages than these on a transformer built upon this pattern, unless the whole is immersed in an appropriate vessel of oil.

The coarse wire winding consists of one layer of No. 12 double covered wire on each spool. These layers will contain approximately thirty-five turns each, but the space should be filled full and the number of turns requisite carefully noted. Beginning at the top of each coil space wind the wire neatly on and bring out the end through the hole in the lower head. To facilitate the winding a spool should be made of three circular pieces of wood, two of them 3 ins. in diameter and ¼ in. thick, and the third 1½ ins. in diameter and 1½ ins. thick. The latter is held between the two former to make a flat spool, upon which the wire for the coil is first wound for convenience in handling it in winding the coil on the core of the transformer. The No. 12 wire for each leg of the coarse wire coil is 44 ft. long, and this length should be cut off and wound up on the spool before commencing the winding.

The two coils, one on each side of the square core, should be wound oppositely, that is, the wire spool should be passed through the frame always in the same direction, so that the wire is laid right handedly on one leg and left handedly on the other of the core. By this arrangement the two bottom wires can be connected to the binding posts 2 and 3 (Fig. 6) and these used for a middle terminal of the coil, while the two upper terminals of the coils are carried to binding posts 1 and 4 on the upper board and serve as end terminals of the coarse coil.

The fine wire coil is laid on over the top of the coarse coil in the same way, but is more carefully insulated. A surface for it is prepared by wrapping a thin sheet of asbestos paper or micanite paper around the coarse coil on each leg, this being temporarily tied in place with a string until several turns of wire are in place to hold it. The terminals of this coil should be brought out through the other holes in the heads as described above. Number 20 double covered wire is used for this coil and exactly ten times as many turns as the coarse coil contains are laid on. If the coarse coil contains thirty-five turns in each leg (as it will approximately) the fine coil should contain 350 turns on each leg, which would come conveniently in five layers, each coil space holding about seventy turns of this size wire. The length for each coil is 450 feet.

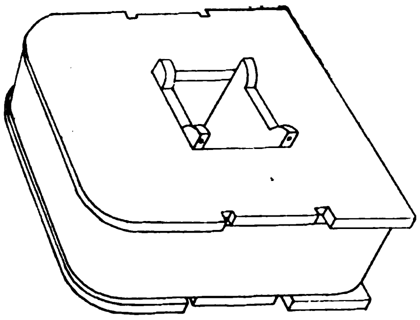


FIG. 5.—SKETCH PRESPECTIVE OF IRON WIRE SPOOL READY FOR COPPER WIRE WINDINGS.

After the coarse wire coil is wound it should be painted with P. & B. or other good insulating compound. In winding the fine wire coil, where high potentials will be used, great care must be taken with the insulation. Each layer should be painted with the compound and wrapped with one thickness of micanite paper before the next is laid on. The terminals of the fine wire coil going to the binding posts on the top board and those on the lower part of the frame should be run in small rubber tubing. The upper board for the posts must be made of hard rubber, or better of slate, which is easily sawed and drilled. Fig. 6, which is a sketch perspective of the finished machine, shows the side carrying the middle terminals of the coarse winding. The fine winding is arranged in a similar way on the other side, two binding posts which are normally connected together being used, but those for the high tension side are to be mounted on a block of hard rubber or slate attached to the wooden frame of the machine. It will add to the safety of the apparatus to put fuse blocks on the upper part of the frame and run the wires from the coils to the upper binding posts through these. After the coils are wound a wrapping of micanite paper should be put on and taped in place for the protection of the coil from mechanical injury.

Referring to Fig. 6, if current at 1100 volts is supplied to binding posts 5 and 8, 110-volt current may be withdrawn from posts 1 and 4, 2 and 3 being connected with a short wire. Or, by connecting 3 to 1 and 2 to 4, 55-volt current may be withdrawn from 1 and 4. Of course the reverse is equally true, the transformer thus acting to either step up or down in the ratios of 10 to 1 or 20 to 1. By supplying 110 volt current to 5 and 8, either 11 or 5.5-volt current may be withdrawn from 1 and 4, while with any voltage supplied to the primary up to the capacity of the machine two voltages may be withdrawn from the secondary, or the transformer may be used as a source of currents for a three-wire system by connecting the middle wire to one of the middle posts of the secondary.

With the winding given 1100 volts is the highest pressure that may be applied to the fine wire coil and 110 volts the greatest allowable for the coarse coil. It is not possible to give the constants of the transformer, as these depend entirely upon the quality of the iron wire, but its efficiency will be excellent, for so small an instrument, if good soft wire be used. The resistance of the coarse coil will be about 0.22 ohm, that of the fine coil about 9.5 ohms, and the capacity of the instrument about 700 watts, or about fifteen lights.

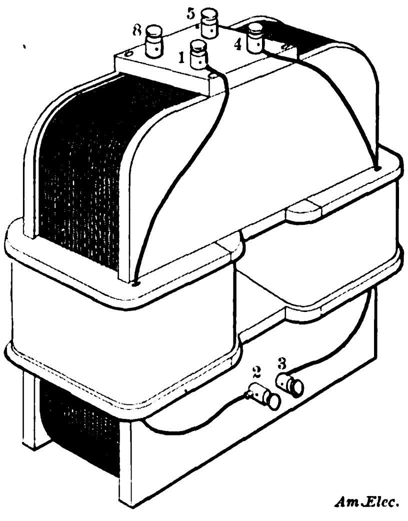


FIG 6.—SKETCH PRESPECTIVE OF COMPLETED TRANSFORMER.

The calculation of a winding for any other ratio of transformation or range of voltages is very simple. Assuming the maximum voltage that is to be applied to the primary, it is necessary to put on this coil a sufficient length of wire to generate a proper counter e.m.f. under the assumed conditions of frequency and voltage. In the figures given above an induction of about 1.25 volts per foot of wire is assumed and this figure should not be exceeded, while for low frequencies 2 or even 3 ft. of conductor per volt should be allowed. Having thus determined the length of the primary coil the next process is to calculate the size of wire needed to carry the current that will be used without undue heating. In coils of this character and of moderate dimensions it is safe to allow a current density of 1 amp. per 1000 c.m. of wire cross section.

The size of the wire being determined, the number of turns in the primary coil should be calculated. Then for the secondary coil the number of turns is given by a simple proportion, the number of turns in each coil being proportional to the voltage at which it is to be used. Thus, if the primary is to work at 100 volts and has 650 turns and the secondary is to work at 25 volts, it must have

$$\frac{25}{100}\ 650 = 162 \text{ (nearly)}$$

turns. All that then remains to be calculated is the size of wire for the secondary and the amount in each coil for convenience in cutting off the wire. If a transformer of larger capacity than that indicated here is desired it may be made in the same way, the dimensions being enlarged so that the cross section of the iron core of the coils is increased proportionally.

If it is desired to work the transformer at high voltages, as, for example, in testing insulators, etc., the fine wire winding should be put outside and divided into sections. The insulation between the coils should be made of heavy asbestos board, say ¼ in. On this should be built up a number of mica rings or separating partitions, made by cutting mica into the desired shape, and making a cut across one corner of the form so that it may be opened out and sprung into place. The thickness of these separating pieces should be about ⅛ in., and the coil included between two of them should not be worked to over 500 volts. In winding the coils into the spaces between the separating mica washers every few layers may be insulated by one or two layers of dry linen or cotton cloth.

When the whole transformer is assembled it should be placed in a stoneware jar large enough to hold it comfortably, and supported in the middle of the jar by wooden pegs of proper length. The jar should then be filled to about 1 in. above the highest point of the transformer with paraffine oil. In this oil insulated type no insulation other than the oil should be applied to the iron wire core or to the windings, that is, no varnish or compound, the cotton cloth being used dry. When the jar is filled with oil it should be gently warmed for a day or two, or better, the transformer should be connected to a low tension source of current (not enough voltage to cause a possible rupture and burn-out anywhere) and short-circuited until it is quite hot and all the air bubbles expelled. The fumes of boiling paraffine oil are very inflammable, and on no account should this oil be boiled on a stove or where its fumes can have access to a fire. Kerosene is an excellent insulating material, but dangerous on account of the inflammable vapors given off when it is heated. In using any oil the jar should first be filled so that about an inch of the transformer is immersed. In half an hour add another inch of oil, and so on, filling the

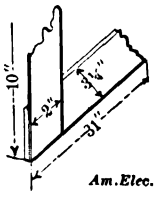


FIG. 7.—END CONNECTION FOR STRIP WINDING.

jar very slowly. In this way the oil ascends through the structure of the transformer by capillary attraction, displacing the air which would, if the jar were suddenly filled, form in bubbles and probably cause a break-down and burn-out somewhere. The wood used in this high voltage type should be absolutely dry.

All leading-out wires should be run in stout glass tubes dipping below the surface of the oil, these tubes being held by the lid of the jar, which is best made of slate. The tubes are put through drilled holes in the slate and cemented in place with plaster of paris. Using the dimensions given above it will be unsafe to wind a transformer of this type for more than about 6000 volts. If higher voltages are required it is far better to make a number of transformers and connect them in series. It should never be forgotten when working with transformers giving these high voltages in the secondaries, especially when insulation tests, etc., requiring the merest trace of current are going on, that fuses just sufficient to carry the magnetizing current for the primary should be included in that circuit. These are very easily made by using a number of tin-foil strip telephone lightning arrester fuses, which blow at about 0.20 to 0.30 amps. in parallel. Unless this percaution is taken the energy of a transformer of the size indicated is quite sufficient to cause fatal results from a shock from the high tension side.

For experiments where large current at low voltage is required, as in electric welding. etc., the secondary is very conveniently made of sheet copper, cut the full width of the winding space and wound on with a sheet of blotting paper soaked in shellac between the turns. Using the coarse coil above described as primary at 110 or 55 volts, a secondary giving 5.5 volts may be made of 1¾ turns of copper strip 3¼ ins. wide and 1-16 or 3-32 in. thick on each leg. Two strips of this should be cut, each 31 ins. long. To one end of each solder a strip of the same material 2 ins. by 10 ins., making an L-shaped arrangement, as shown in Fig. 7. This end piece is for the terminal connection. Start the winding on the side of a coil facing the end of the apparatus and take one complete turn. Then paste on a sheet of shellacked paper and take another turn with the copper strip, so that the end is left pointing toward the other coil at the back of the transformer. Do the same thing in reverse order on the other coil, and sweat together the two ends that are left. With a current of 110 volts and 7 amps. in the primary, this arrangement will give about 140 amps. at 5.5 volts in the secondary.

The uses to which such a transformer may be applied are numerous and will readily suggest themselves. Wound for about 30 volts in the secondary the size given is large enough to feed a small electric furnace. With the copper strip secondary electric welding of small objects may be done. With the oil insulated type insulators may be tested and the remarkable phenomena of high tension alternating arcs shown.

ERECTING A HIGH VOLTAGE TRANSMISSION LINE—II.

BY S. H. DAILEY.

In this article it is supposed now that the poles are all delivered at the proper places, and that the gains are cut on a sufficient number to permit going ahead with the digging and raising.

The proper way to proceed at this point is to dig as many holes in the first part of the day as there can be poles raised in the last part, thus finishing the raising and setting of the poles as far as the work goes for each day complete, leaving nothing to do but string the wire to finish the line.

In consideration that the average length of poles in this case is 36 ft., it will require at least six men to raise the same, and for a gang of this size five sets of digging tools should be provided. On an average one man can dig eight holes 5 ft. deep a day of 10 hours, or one hole in 1 hour 15 minutes. Thus, with five sets of tools, there should be twenty holes dug in a half day, and the same number of poles can be raised and set during the afternoon of the same day.

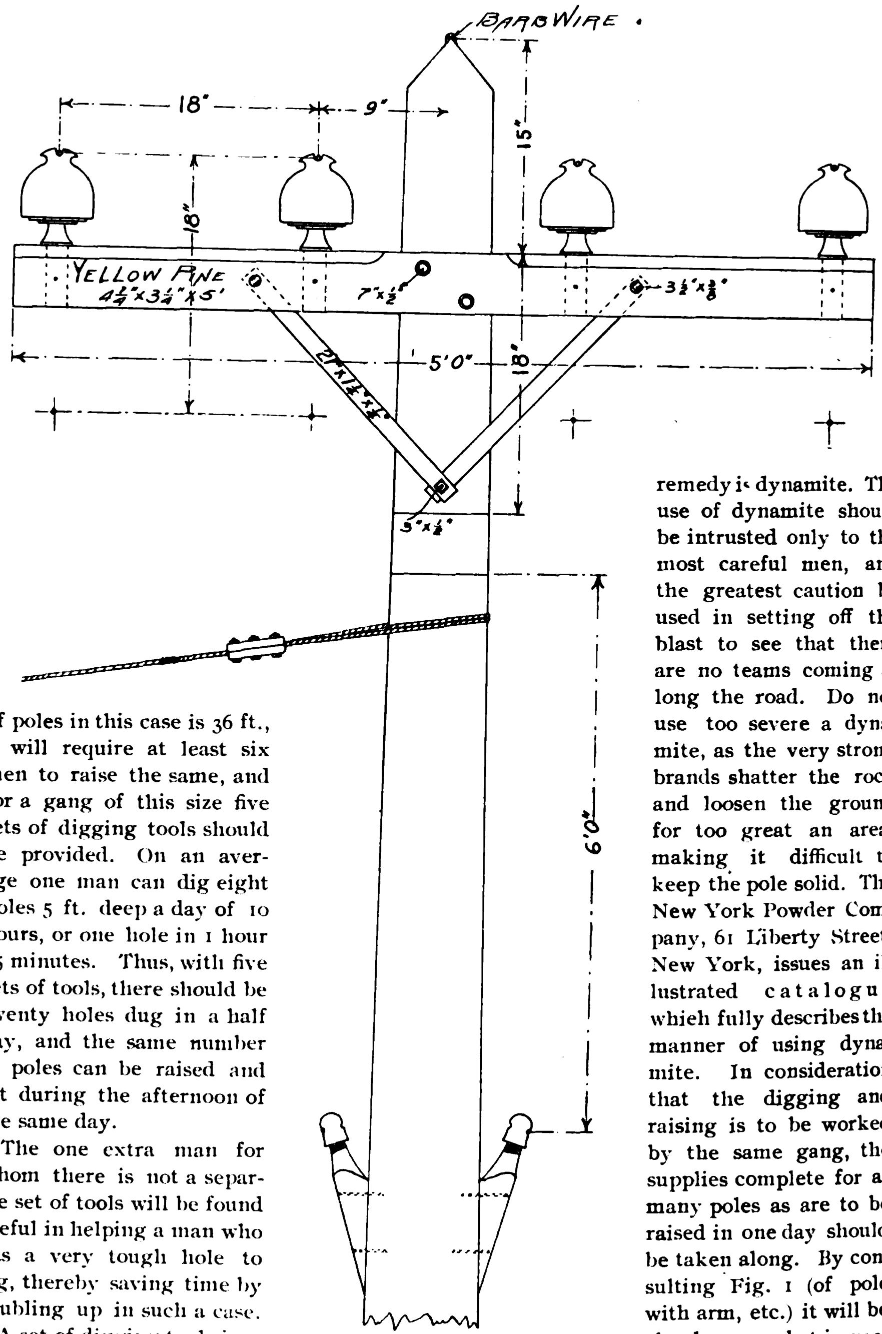


FIG. 1.—POLE WITH ARMS AND INSULATORS.

The one extra man for whom there is not a separate set of tools will be found useful in helping a man who has a very tough hole to dig, thereby saving time by doubling up in such a case.

A set of digging tools is as follows: One spoon shovel, 7 ft. handle; one round-point shovel, 7-ft. handle; one digging iron, 8 ft. long. The shovels may be purchased from an electrical supply house, but the digging iron can be made by a blacksmith. It should be 8 ft. long, of octagonal steel 1⅛ ins. diameter on sides, and will weigh about 28½ lbs. One end should be flattened and the other pointed. The sharp corners may be taken off with a rough file, making it easier on the hands.

When commencing a hole use the peg as the center and do not make the hole too large, governing the size by the pole to be set in it. Be careful to keep the hole of a uniform size during the digging—a caution necessary, as the most natural tendency is for it to become small at the bottom; this may make trouble in erecting, as the butt of the pole may bind and cannot be turned so as to line as easily as if it had a little play; at least 2 or 3 ins. around the pole should be allowed for tamping.

If rock interferes with digging, the only remedy is dynamite. The use of dynamite should be intrusted only to the most careful men, and the greatest caution be used in setting off the blast to see that there are no teams coming along the road. Do not use too severe a dynamite, as the very strong brands shatter the rock and loosen the ground for too great an area, making it difficult to keep the pole solid. The New York Powder Company, 61 Liberty Street, New York, issues an illustrated catalogue which fully describes the manner of using dynamite. In consideration that the digging and raising is to be worked by the same gang, the supplies complete for as many poles as are to be raised in one day should be taken along. By consulting Fig. 1 (of pole with arm, etc.) it will be clearly seen what is necessary for each pole, which will be as follows:

One cross arm, 4 pins and nails; 4 insulators, high-voltage line; 2 insulators, telephone line; 2 brackets and nails, telephone line; 2 7-in. x ½-in. lag bolts and washers; 2 braces; 2 3½-in. x ⅜-in. carriage bolts and washers; 1 3-in. x ½-in. lag bolt.

To save time, the pins should be put in the arms before being taken to the work. They should be dipped in paint up to the thread, and after being driven in the cross-arm, secured there by a wire nail.

A wagon large enough to hold all the supplies and tools needed for one day's work should be used.

It will be found convenient to have a set of 4-in. block double sheave, with ⅝-in. diameter rope about 300 ft. long, with the supply wagon, which can often be used in pulling poles around or up the side of a bank.

As the poles to be raised are not more than 36 ft. on the average, it will be found just as easy to erect them with the cross-arms on, thereby saving time, as the work of putting on an arm when the pole is set is at the best a long job; and with the arm on the pole it will be easier to line it up. So let two of the men go ahead of the gang and begin to put the arms on. After the raising is commenced, this should be done while the last pole set is being tamped.

In putting the arm on, notice that it sets square to the center line of the pole before tightening up the 7-in. bolts and 3-in. brace toe bolt. The arms should be set on the pole, and after starting the bolts with the hand axe they should be drawn up with a wrench, not driven all the way.

◆

INTERIOR WIRING.

CONTROL OF LIGHTS AND BRANCHING.

BY CHARLES F. KNOX.

But little now remains to be considered in regard to laying out the branch circuit work. We have already discussed the questions of locating the distributing center with regard to the branch circuit wiring, limiting length of circuits, the number of outlets and lights that may be wired on any circuit, the loss that may be allowed in the branch circuits, the method of determining the loss, and the question of local control. We will now consider the questions of controlling the lights in large groups and of "branching out" at outlets, and then pass on to the feeders and mains.

Of course it very frequently happens in a large room, such as a ballroom, for example, that a switch controlling only one or two circuits is undesirable. The reason for this is that in a ballroom there are usually a great number of lights, and consequently a large number of branch circuits, and if any of the lights are used at all they are generally all used; it would be useless to control each branch circuit when they might better be controlled in groups. Besides, it would increase the cost without any corresponding advantage gained, unless it be an advantage (and apparently that is what some people strive for) to raise the amount of the contract.

In such cases as these, push button or snap switches are rarely adapted for carrying currents exceeding 15 amps., and as knife switches should be located in the cabinet containing the cutouts, the distributing center should be located with reference to the lights controlled, and the lights may be then controlled by knife switches in any manner of grouping. As a rule, in private houses this distributing center or subsidiary switchboard is located in the butler's pantry. In hotels it is generally located in one of the halls in the service department. If it is essential, however, that the lights be controlled locally in large groups, automatic switches may be used, as suggested in the last number.

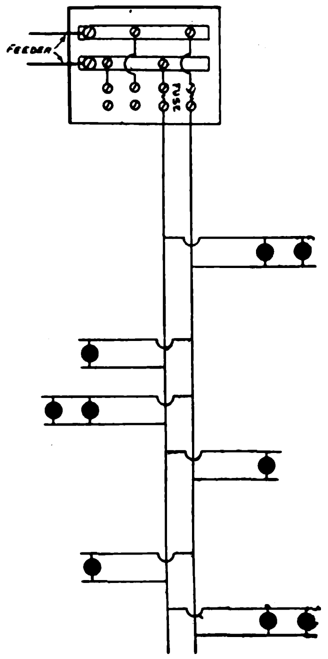


FIG. 1.—TOP OR BRANCH WIRING (EXPOSED).

It very frequently happens that owing to the length of the branch circuits it is impossible to run them from the point of control. In this event the mains controlled by the switches are extended to centers of distribution located near the lights supplied, the branch circuits being supplied from these centers.

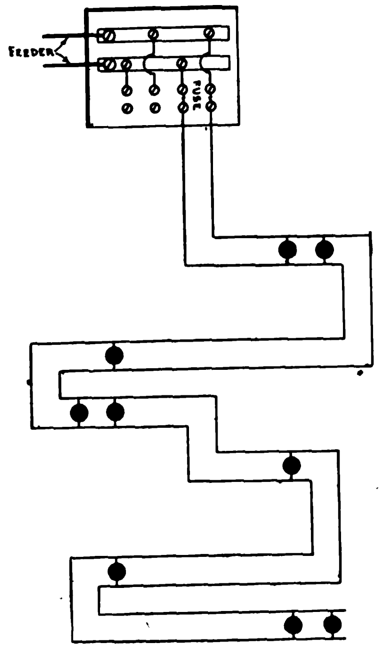


FIG. 2.—LOOP WIRING.

Now as to "branching" little need be said. By "branching" is meant the subdivision of one circuit at any outlet into two or more branches. Formerly it was the universal practice, where the wiring was exposed, to run a circuit of No. 8 or 10 wire down a room or along the hall and then to take or branch off wherever one or two lights were needed (see Fig. 1). Now, however, it is almost the universal practice to run the circuit work on the "loop" system; i. e., the circuit is run from the distributing center to the first outlet, thence to the second outlet, and so on, taking each outlet in turn (see Fig. 2).

The disadvantages of the "tap" or "branch" method of wiring are that it increases the number of joints or connections, and makes it harder to trace the course of the circuit; in concealed work it also has the disadvantage of increasing the number of conduits at a given outlet, and if outlet boxes are not used and a single wire run in each tube this last disadvantage is enough to entirely offset the slight gain in economy which it has over the loop system. In the days of brass armored conduit and before outlet boxes were used, if a branch were made at an outlet, it required a 5-in. and frequently a 6-in. canopy on the fixture to cover the conduit ends.

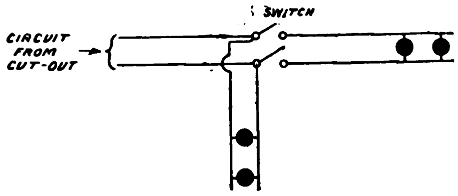


FIG. 3.—BRANCH AT SWITCH TO LIGHT OUTLET.

It happens quite often, however, that it is essential to sub-divide the circuit into two or more branches. For example, in the case of a local switch controlling only a few lights it is the general practice to subdivide the circuit at the switch, one branch of the circuit supplying the lights controlled, the other branch taken from the rear (or uncontrolled) side of the switch, supplying lights not controlled by that switch (see Fig. 3). If this were not done it would always be necessary to place the switch and the lights it controlled on the end of a circuit, and where there were a large number of local switches, each controlling a few lights only, the number of circuits would have to be equal to the number of local switches; otherwise there would not be enough ends to "go around"; it would frequently happen, then, that there would be only three or four lights on some of the branch circuits, and this would be uneconomical; the length of the branch circuits would also be considerably increased, as we would have to supply all

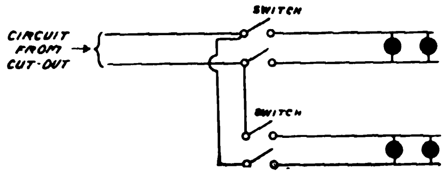


FIG. 4.—BRANCH AT SWITCH TO ANOTHER SWITCH.

the other lights on the circuit first and then run to the switch.

For these reasons it is, therefore, frequently desirable and necessary to "branch" at a switch. Where two switches are placed together and the number of lights which they control is not greater than twelve (Fire Underwriters' limit for one fuse) they may be fed on one branch circuit, supplying one switch and then branching to supply the other (see Fig. 4).

Sometimes it is even allowable to "branch" at an outlet other than a switch (see Fig. 5). As a rule, however, there is less necessity for doing this than there is for branching at a switch and the disadvantages are greater. It is, therefore, to be avoided except where necessary.

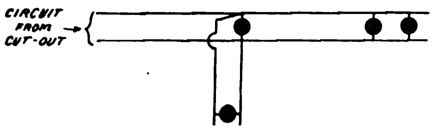


FIG. 5.—BRANCH AT OUTLET TO ANOTHER OUTLET.

Where a switch located at the distributing center controls two branch circuits, it is best to run one circuit to the switch and then sub-divide into two circuits, provided the current on the two switches does not exceed 6 amps., which is the limit allowed to be fed through a branch circuit fust.

AMERICAN TELEPHONE PRACTICE.

SELF-RESTORING SWITCHBOARD DROPS

KEMPSTER B. MILLER.

The drop and jack of the Western Telephone Construction Company was the first of this type to come into extended use. It is shown in Figs. 1 and 2, Fig. 1 showing the shutter in its normal position, and Fig. 2 showing it after it has been thrown down by an incoming call. In these figures the arrangements are such that the spring jack J of a line lies directly in front of the actuating coil E, belonging to that line, and the shutter C so arranged as to fall directly in front of the jack when released by the armature F. The combined jack and drop are mounted on a base of hard rubber A. The armature F is pivoted in the front head H of the electromagnet by the pivot screw P, and has a forwardly extending arm adapted to support the shutter C in a horizontal position. A small leaf spring S normally holds the rear end of the armature away from the rear head H of the coil and in a position to be attracted by that head when a calling current is sent through the coil. The attraction of the rear end of the armature causes its front end to move sidewise and release the shutter, thus allowing it to fall into a vertical position and display itself to the view of the operator, as shown in Fig 2.

In order to make a connection with the line the operator inserts her plug directly against the shutter, which is down, and in so doing restores the shutter to its normal horizontal position by a positive mechanical movement. The plug is guided into its jack by the shield or guide-plate K. In entering the jack the spring J is lifted off of the anvil I by the sleeve of the plug, thus breaking the connection through the coil of the drop. The spring J makes contact with the sleeve of the plug, while the spring shown on the under side of the jack makes contact with the tip of the plug, thus continuing the tip and sleeve sides of the line to the two strands of the plug cord.

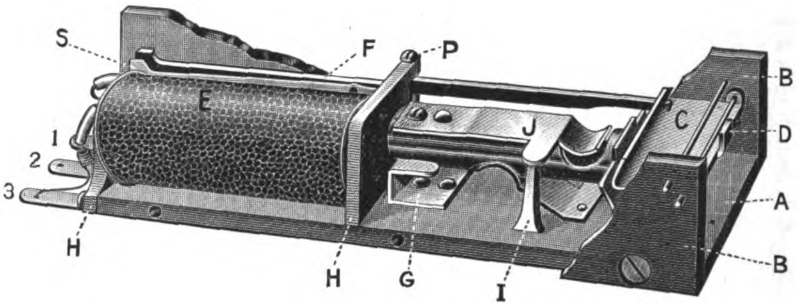


FIG. 1.--WESTERN TELEPHONE CONSTRUCTION JACK, UP.

These drops and jacks are mounted into a sort of an "egg case" composed of the bases A and the hard rubber side pieces B B. These egg cases usually contain one hundred compartments, ten wide and ten high; 1⅛ inches is allowed in each direction between the centers of the jacks. The wires on which the shutters are hung are common to each horizontal row of ten, and the other wire shown is also common to each row of ten. These two wires form the terminals of the night alarm circuit, and when a shutter is down the lug D on the shutter strikes against the rear wire, thus making connection between the two and causing the night bell to ring.

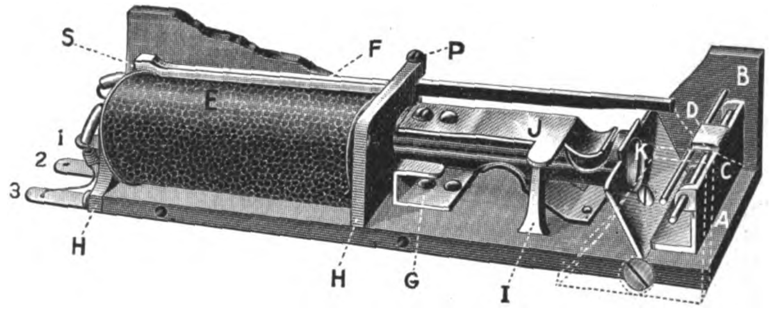


FIG. 2.—WESTERN TELEPHONE CONSTRUCTION JACK, DOWN.

This combined jack and drop has given good satisfaction in practice, and possesses advantages not to be found in the electrically restoring type of drops. In the first place, all the additional coils on the drops, and the additional contacts on the spring jacks and the additional wiring between the two, is entirely done away with. The action of restoring the drop by direct contact with the plug is so positive that it cannot fail. Another advantage, and one that is usually overlooked, is that when the drop falls the eye of the operator is attracted directly to the point into which she must insert her plug; while in the forms where the jacks and the drops are entirely removed from each other the operator must first look at the drop, ascertain its number, and then look for the corresponding number of jack on the board below. This very materially increases the ease of operation, and consequently tends in itself to give more rapid service.

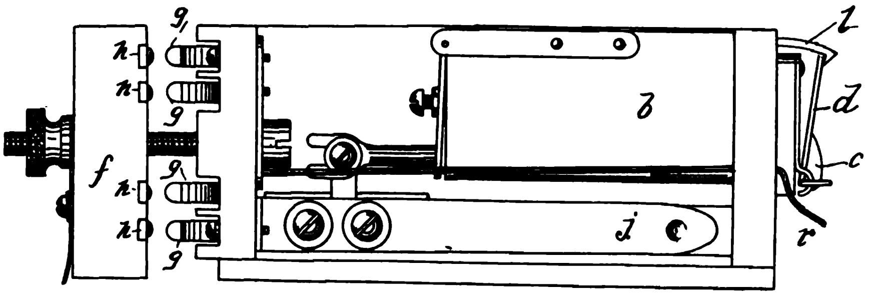


FIG 3.—ELEVATION OF AMERICAN ELECTRIC JACK.

The other form of mechanically self-restoring drop is that now manufactured by the American Electric Telephone Company. In this drop, which is shown in Figs. 3, 4 and 5, the actuating coil a is mounted directly above the spring jack j. The coil is incased on all sides except the top in a sheet iron shield or box b for lessening the amount of induction between adjacent drops. The armature of the magnet is pivoted at the rear of this shield and carries a forwardly projecting lever l, which in turn carries on its forward end a catch for holding the shutter d in its vertical position. On the shutter is placed a cam c, which when the shutter is down lies in front of the opening o of the jack. The plug shown in Fig. 11 carries an enlargement or collar k, which collar engages the cam c on the shutter when the plug is inserted into the jack, and forces the shutter into its normal position.

No cut-out is provided for the coil,

which is therefore left in series in the line during a conversation. The coil therefore serves as a clearing out drop, and when so actuated the cam on the shutter falls in front of the collar on the plug. When, therefore, the plug is withdrawn from the jack, after the clearing out signal has been sent, the cam again engages the collar on the plug and the shutter is restored again to its vertical position.

Another feature of this device is that when the plug is pushed to its fullest extremity into the jack the collar on the plug comes into contact with the front of the board and is depressed backward against the tension of a coil spring carried in the plug. This action wedges the line spring in the jack against a generator contact located in proximity thereto, and thus sends ringing currents out over the line. When the pressure on the plug is released the coiled spring forces it out of the jack to a slight extent, and thus restores the contact between the line spring and the contact of the plug.

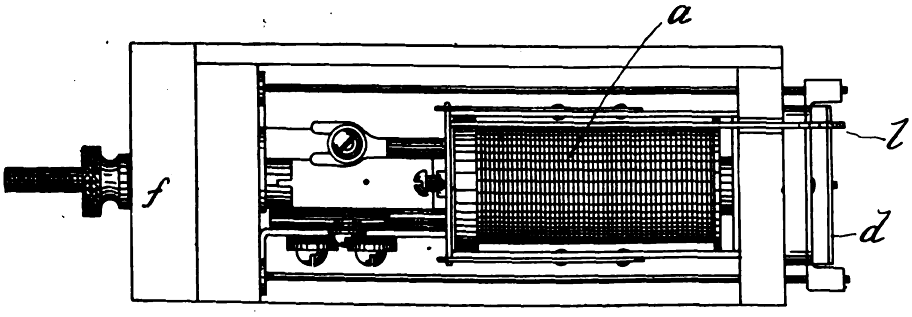


FIG. 4.—PLAN VIEW OF JACK.

The entire structure of the combined drop and jack is removable from the board by taking off the thumbscrew shown in the rear. This screw passes through the board forming the frame of the switchboard, and serves not only to hold the jack and drop in place, but to establish a connection between the line wire and the line spring of the jack. Small springs on the back of the jack register with corresponding contacts on the front side of the backboard, thus serving to extend the night alarm and generator circuits from the jacks to the other parts of the switchboard. By this means the proper connections are automatically made when the jack is slipped in place.

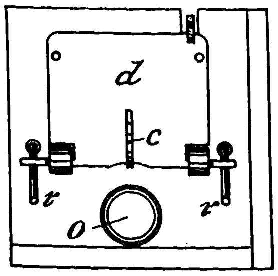


FIG. 5.—FRONT VIEW OF JACK.

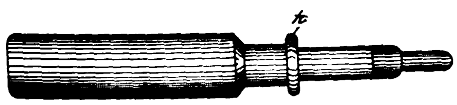


FIG. 6.—JACK PLUG.

Many other forms of mechanically self-restoring drops have been devised, but the two types here described have come into by far the most general use.

As an illustration of the saving which the self-restoring drops bring about in the operation of switchboards, certain boards have been devised and put into use where the drops are of the ordinary hand-restoring type, placed in series in the line and not cut out by the insertion of the plug. In the establishing and disestablishing of a connection between two subscribers the operator was required to restore a switchboard drop four different times. First she restored the drop of the line of the calling subscriber, next when she sent a calling current to the line of the called subscriber this current passed through the drop of that line, causing it to fall. This she also restored by hand, and lastly when one or both of the subscribers rung off the drops of each line fell and were restored by hand, thus making four in all. Such switchboards are, of course, necessarily slow. Moreover, they are almost invariably much larger and more cumbersome than the more modern types, but even these great drawbacks have not interfered with their giving fairly satisfactory service in some cases in small exchanges.

SOME STEAM PACKING.

BY JAMES F. HOBART.

It is well for every engineer to spend a few hours in the study of packing of different kinds. I believe there are several hundred varieties in the market, and they are made of all sorts of material.

They may be divided into metallic and textile. The metallic packings are usually made of Babbit or some other soft metal. I have seen metallic packing made of ordinary solder, such as is used by plumbers. It worked very well. In selecting a metallic packing it must be borne in mind that steam pressure sets the packing tight against the rod. Therefore great care should be exercised in screwing up the gland to make sure that no excessive pressure is put upon the packing.

All kinds of metallic packing should be made so as to approximate any shape of the conventional ball and socket so frequently used in mechanics. In applying this principle to metallic packing it is sufficient to make it into two parts, one fitting within the other and made concave and convex. The outer faces of the parts are flat and bear against the gland and packing box respectively.

This allows the packing to follow the rod, no matter whether the gland be screwed down evenly or not. It is important in this class of packing to make the faces or ends of the packing parallel, and give them a considerable space sidewise in the packing box. When this is done the packing can follow the rod laterally to a considerable extent, which enables the packing to follow the rod and keep it steam tight, even when it is considerably out of alignment.

Of the thousand and one varieties of textile packings, I will write at this time only of the asbestos variety. Asbestos works well in heat as long as the heat is dry, therefore for packing valves or rods which are only to be exposed to dry steam, asbestos leaves nothing to be desired. Unfortunately it is never safe to assume that the packing on any steam system will not at some time come in contact with water or moisture. In fact, the reverse is to be expected.

Water is a natural enemy to asbestos; nothing will destroy the working qualities of asbestos as quickly as contact with water. For this reason valves or rods should not be packed with that mineral and exposed to the action of water or wet steam.

The asbestos, even if it does not go to pieces, seems to "lose its grip" and becomes little better than so much dirt in the packing box. To remedy this defect a great many schemes have been tried, such as mixing the asbestos with rubber, with plumbago, and with soapstone. All these help the trouble, but none seem to cure it.

We frequently buy in the market a kind of packing which seems to be composed of alternate layers of asbestos and rubber. This packing is made by braiding asbestos threads around a core, which is also formed of asbestos. The braided rope is then passed through a solution of rubber and a portion adheres. After the coating thus applied has become dry to a certain extent, another layer of asbestos is put on. This operation is continued until the desired size of packing is reached.

Sometimes plumbago is substituted for the rubber or even mixed with a certain proportion thereof. In this case only sufficient rubber is used to hold the plumbago in place. Soapstone is also used considerably in asbestos, and also in other forms of packing. Ordinary asbestos wick packing I have seen loaded with 50 per cent of its weight of powdered soapstone. This is probably a benefit, for I think soapstone a much better packing than asbestos under all circumstances; provided it can be placed where it is wanted and kept there while the work is being done. Its structure is, however, not of a fibrous nature, and it must therefore be securely supported by some fibrous material.

The asbestos which comes in a square form often gives the outsider a good deal of trouble in guessing how it is made.

For the benefit of those interested, I will state that it is first braided up in the round form, then run through one or more sets of rollers and rolled in the desired shape, precisely as iron or other metal is rolled into bars either flat or square.

In using square asbestos packing be careful not to place too great a pressure upon it, for owing to the suction, this packing fills the gland completely full and when pressure is applied becomes very solid; thus when excessive pressure is applied to the stuffing box the packing becomes as hard as iron, with no elasticity. This does not happen to so great an extent when round packing is used. The shape leaves spaces between the layers of packing into which it can expand slightly when undue pressure is applied.

LESSONS IN PRACTICAL ELECTRICITY

HOW TO DESIGN A DYNAMO.

The reader who carefully peruses the following set of lessons must not expect to emerge from his study a perfected dynamo designer. All that is expected and hoped for is to give the student an idea of what must be taken into consideration in designing a machine and possibly to assist him in making moderately successful small bi-polar designs.

The formulæ and other data by the aid of which the dimensions of a direct current machine are determined are of a varying character. Some are magnetic, some electrical and some mechanical, and of all of these some are rational, that is, deduced from scientific laws, and others are empirical, that is to say, they are modeled to fit the facts as they are experimentally found and are the result of practical experience. Almost every designer has his own ideas as to the best empirical formulæ. By far the best way to understand how to design a machine is to follow through the methods employed in designing an actual machine taken for an example.

To this end we will assume that we are designing a 100-light dynamo of the high speed, belted, drum armature type. The machine is to be of the simple horseshoe form, with the armature uppermost. It is to operate at 110 volts and is to have a margin for compounding. The compounding is to be 10 volts. The prescribed speed of the dynamo is to be 1500 r.p.m. These are all ordinary commercial conditions and very easy to fulfill.

The first step is to calculate the total current output of the dynamo. An ordinary incandescent lamp takes an average of ½ amp., and the machine will, therefore, have a total current output of 50 amps., which must be available for the outside circuit. In addition to that we must have some current for the purpose of exciting the fields. In such machines as this it is found that the fields can be excited with about 6 per cent of the total output of the dynamo, that is to say, 3 amps. in this case, making the total available current 53 amps. If, therefore, we calculate a wire for a machine which can deliver 55 amps. we shall have an ample margin.

The machine is to be of the bi-polar type and consequently there are two circuits in the armature, each of which must carry half the total current, viz., 27½ amps. The first question therefore arises, how much must this wire be to carry the current without heating. In this case we must resort to practical considerations and note just what has been the results with other armatures. A single wire freely suspended in mid-air will carry much more current than if tightly wound into a bobbin. The following table, which has been prepared by a prominent designer, is a very safe criterion by which to go:

	Amps. per square inch.
Small high-speed armatures.......	2500 to 3500
Large " "	1500 " 2500
Small low-speed armatures	1500 " 2000
Large " "	1100 " 1600

However, heating is not the only consideration. We want an armature of low resistance, because there will be less drop in such an armature and the regulation will be better. Therefore, these figures represent the limits to which we may go and not necessarily the wire we shall choose. Consulting the table, we see that, as this is a small, high-speed armature we may safely assume a current density of 2500 amps. per square inch. If we are to deeply notch this armature with teeth and thereby bury the conductors in a confined space, we shall have to choose a lower density. Modern armatures are built in this way, and therefore we may select 2000 amps. per square inch as a suitable value to adopt in fixing the size of our armature wire.

The calculation is a simple proportion. The wire carries 27½ amps., and it is obvious, therefore, that its sectional area should be $\frac{27\frac{1}{2}}{2000}$ in., which is equal to .013625 sq. in. Here an economical consideration enters. It would not pay to have a special wire drawn for such a small machine as this and we must choose the nearest standard size. Consulting a wire table, we find that the nearest standard size is No. 8 Brown & Sharpe wire, the area of which is .012966. Then the question arises, How large must we make the armature core and how many of these wires shall be wound upon it?

The size of the armature core depends almost entirely upon the number of wires that it must carry. It must have sufficient circumference to hold them all and also to make room for teeth. To determine this we must make a preliminary calculation. The total e.m.f. which this armature must generate is 110 volts for the lamps, 10 volts for the drop in the line, and we must further add a percentage for the drop in the armature. If we choose 130 volts as the total voltage the machine must generate, we shall be on the safe side.

The voltage, speed, flux and number of conductors on a direct current bi-polar machine are related as indicated in the following formula:

$$E = \frac{NCr}{100,000,000}$$

in which E is the total e.m.f. of the machine, N is the total number of lines of force, C is the total number of conductors on the surface of the armature, and r the revolutions per second. Of these various factors, we know the following:

$E = 130.$

$r = 25.$

Substituting these in the formula, we find that the product NC must equal 520,000,000. We are now at liberty to choose any value of flux and number of conductors which will multiply to that product. Here we must refer to practical experience to find out what is suitable in such a case. The following table serves to show the total fluxes employed in dynamos of various capacities of the high-speed drum type.

Capacity in Kws.	Conductor Velocity. Feet per Second.	Average Useful Flux. Lines of Force.	Average Leakage Coefficient.
.1	25	200,000	2.00
.25	30	333,000	1.90
.6	32	550,000	1.80
1	34	880,000	1.75
2	36	1,530,000	1.70
3	40	1,875,000	1.65
5	45	2,550,000	1.60
10	50	4,000,000	1.55

Our machine can run 100 lights and is, therefore, a little over 5 k.w. capacity, and hence we may assume any number of conductors that gives us a flux in the neighborhood of from 2,000,000 to 3,000,000 lines. If we assume 3,000,000 lines as a flux, we shall find that we need:

$520,000,000 \div 3,000,000 = 173\frac{1}{3}$ conductors.

Of course, we cannot have a fractional number of conductors, but we can easily have any magnitude of flux we wish. Experience has shown that it is very convenient from a mechanical point of view to have the number of bars in the commutator and therefore the number of conductors on the armature a multiple of six. Hence we may select 168 conductors as a convenient compromise, and dividing this quantity into 520,000,000 we find for our total useful flux 3,095,240 lines of force, nearly.

We are now concerned about the size of the core upon whose surface these 168 No. 8 wires are to be placed. No. 8 double cotton-covered wires, laid side by side in a winding, run about 6.66 turns to the inch, and if we laid these wires side by side around the circumference of a smooth surface armature, it is obvious that the circircumference would be 168 ÷ 6.66 = 25.25 ins., giving us an armature some 8 ins. in diameter, which would be large for such a machine. It is evident that we must pile the wires one on top of the other in order to reduce the size of the armature. If we pile the wires two deep we would have an armature a little over 4 ins. in diameter, which would be small, but if we allow a tooth width equal to a slot width, we should be back at 8 ins. diameter. If we pile the wires four deep, the armature diameter would be 2 ins., but the teeth will add over 2 ins. more and the slot insulation will add still more. We may, therefore, make a preliminary calculation on this basis. Those who have read Prof. Rice's article will appreciate the fact that it is desirable to use two coils per slot. The reason for having the wire a multiple of six now appears, for we can arrange our coils without having an odd number of slots or segments. In such a small machine it is not advisable to have too many slots, as it adds to the expense. It is obvious that the wires in the slot must be a multiple of four. If we assume four wires per slot, we shall have four wires per coil, and forty-two slots and forty-two commutator bars. This is convenient, for we shall have twenty-four bars across 110 volts, which is a little over 5 volts per bar, and there are enough bars to avoid pulsating currents. Moreover, a bobbin of two turns is not very inductive, which conduces to sparkless running. The slots should be at least of the following width to make room for the various insulating materials:

No. 8 wire	128.5 mils.
Fuller board trough	70 mils.
Insulation	25 mils.
Giving a total slot width	223.5 mils.

As these should be straight slots, because the wire cannot be wound four deep conveniently in any other construction, the teeth will be wedge shaped, being broader at the circumference than at the root. Practice has shown that it is not wise to have the root of the tooth less than 60 per cent of the width of the slot. We then have the following items to make up the circumference of the armature: 42 slots at 223.5 mils. each, equal 9.387 ins.; 75 per cent more for teeth, 7.04.; giving a total circumference at the base of the slot of 16.427 ins. The depth of the slot is, of course, equal to:

Four thicknesses of No. 8 insulated wire equals	614.0 mils.
One thickness of paper insulating trough	35.0 "
3-64 of an inch for clearance and band wires	46.8 "
Total	695.8 mils.

It is obvious that, if we add double this distance to the diameter of the armature computed from the roots of the teeth, we shall have the diameter of the finished core disc. This quantity is 5.22 ins., to which we add 1.39 ins., giving us 6.61 ins. as the core disc diameter. We will find it better to choose 6½ ins., because that is a standard size. The difference will be a slight narrowing in the thickness of the teeth at the roots, but it will not reduce them to less than 60 per cent of the width of the slot.

Having computed the diameter of the core disc, we must determine the length of the armature, approximately. This is determined by the density of flux per sq. in. which it is wise to carry. In armatures of this type it can be safely advanced to 70,000 lines per sq. in. We have approximately 3,000,000 lines, which means that the fluxed area of our armature must be at least 43 sq. ins. The effective flux carrying diameter of the armature, as we have computed, is about 5¼ ins. From this we must subtract 1¼ ins. to allow for a shaft, leaving us an effective iron diameter of 4 ins. Dividing this into 43, we obtain a length of 11 ins. for the assembled core discs. Having thus computed the general dimensions of the armature it is necessary to make some calculations to see whether or no it will overheat. These will be considered in the next lesson.

Letters on Practical Subjects

Oil Economy.

To the Editor of American Electrician:

I happened to be in a shop where they made electrical work, and was impressed with the amount of oil wasted on the screw cutting machines, and especially on the various drilling machines used on heavy work. Oil was simply used by the quart and no one seemed to think of catching any of the oil again, at least as long as the chips from the cutting tool would take up and hold all the oil that was ladled upon the tool.

I want to compare the above noted shop with another where not one-tenth the oil is wasted that is got away with in the first mentioned shop. There oil is used as freely and the quality is as good, if not better. Under each machine is a concern which looks a good deal like an ordinary cuspidore. The top is made funnel shaped, and the bottom dish in which the flaring top sets is about 6 ins. deep and 10 ins. in diameter.

The flaring top is made of sheet iron 1-16 in. thick, and drilled full of ⅛ in. holes. A double flaring shape is then cut out, bent in the form of a cone, and riveted. This forms the perforated funnel which appears in the top of each oil dish, and which catches 99 per cent of the chips, which either fall or are thrown into the funnel. All chips and borings from the oil-using cutting machines are placed in one of these cones, and allowed to drain thoroughly before they are removed from the machine, or from beneath it. Then the cones are dumped into one made on a much larger scale, but built in a steel cylinder, around the inside of which is a coil of steam pipe. Here, about all the rest of the oil is "tried out" and the entire quantity is then filtered and used again. But considerable of the oil from the first strainer box, or filters, is put right back in the machine by the operator.

SAMUEL SWEET.

Providence, R. I.

Motor Action.

To the Editor of American Electrician:

Some time ago I wrote you about the action of a motor (direct current), as to whether it was ferric attraction between the pole pieces and the armature core, or if it was the thrust which lines of force give to a conductor carrying a current. You recommended me to look up "American Electrician," July, '96, wherein is an article by Mr. Townsend Wolcott, in which he explains that the first is the case in a slotted armature and the latter in a smooth core.

Now here is an incident which, I believe, fully confirms the first part of the problem, viz., that of a smooth core armature. The shop I work in recently had to repair a direct current bi-polar shunt motor. The owner complained that upon the throwing of the main switch and operating the starting box, the wire and commutator turned around while the shaft and pulley stood still. The armature is an old style one, in which the coils are wound between driving pegs; the armature is then banded and the pegs pulled out so that its own friction is all that holds the wire to the core. The commutator also is held to the shaft by friction, and the motor being about fifteen years old, it had become loose enough to turn with the wire, which was lucky for the armature connections. The only explanation that I can see is that of Mr. Townsend Wolcott, as above noted.

Yours very truly,

A. K. B.

Hamilton, Ohio.

How They Will Behave.

To the Editor American Electrician:

Will any of your readers who may have had experience with similar magnets, kindly inform me of the probable behavior of the pair described herewith? Each one of the pair is designed to pull 450 lbs. at a distance of 0.5 in. The core of each magnet is made of the best and softest iron to be procured, and is 1 in. thick, 12 ins. wide and 24 ins. long from extreme end of pole-piece to junction with yoke. The magnet is of the ironclad type, the case or shell inclosing the core and the winding being used to form the other pole of the magnet. The shell or case is made of "50 carbon cast steel" and is consequently pretty hard, and capable of retaining permanently more or less of the magnetism imparted to it by the coil.

The winding is of copper wire, .036 in. diameter (about No. 19) and is put on .25 in. thick, and carries a current density of 4000 amps. per sq. in. The case is made (cast and machined inside) 14½ ins. wide, 26 ins. long and 3¾ ins. thick, the hole inside being large enough to receive the soft iron core with the winding on it, ¼ in. thick, as stated.

The winding is to be absolutely water tight, and this is secured by rabbetting the core 1-16 in., and counterboring the end of case the same amount; then a phosphor bronze washer is forced into the channel thus made, and both the case and the core carefully riveted down on to the bronze. The wire enters the case through a stuffing box and is grounded on the magnet core. The wire cavity is therefore sealed perfectly air and water tight. What will be the effect of prolonged passage of current through the apparatus just described, the rise of temperature figuring 50 degs. above the temperature of the surrounding atmosphere?

Another point. Two of these magnets are to be set up opposite each other, the armature upon which they are to act alternately being ½ in. less in width than the distance between the poles of the magnets. It is proposed that the residual magnetism of the steel magnet case shall hold the armature against the poles of the magnet last energized until current is sent through the opposite magnet. Then, the two being connected together, iron and iron, the wiring of the one magnet shall be so connected that the act of energizing shall destroy the residual magnetism in the other magnet, thus releasing the "electric lock" and permitting the opposite magnet to attract and pull over the armature, where again it is in turn held by the residual magnetism as before.

The magnets are fastened to a considerable piece of steel of the same composition as the magnet cases, which are made ironclad form to prevent their magnetism from being absorbed by the body of metal instead of by the armature. How will this scheme work?

James L. Francis.

Brooklyn, N. Y.

Electrical Coffeepot.

To the Editor of American Electrician:

For several months my business took me to an office in a part of the city where there were no restaurants, and the problem of a warm lunch at noon became a serious one. It was finally solved by the setting up of an electrical cooking bench in the office and the construction of two or three electrically heated utensils.

The coffee pot was first made, then other dishes were added. An ordinary two quart agate coffee pot was procured and a piece of asbestos paper was fastened around it, close to the bottom, and extending up about five inches. For the resistance wire, some of the German iron wire used by some makers in electric car heaters was procured, sometimes called "Krupp iron" wire.

About 40 ft. were necessary to give a resistance of about 27½ ohms. This wire was bare—it did not come insulated—and a coil was wound on the lower part of the coffee pot, the convolutions being kept about one-half inch apart. Then the wire was held very tight, and some hot asphalt was daubed on. Then another piece of asbestos paper was put in place, and the winding continued until all the wire was on. Then another daub of asphalt, and another layer of paper finished the pot.

A flush wall socket was let into the plaster of the office, and the coffee pot wiring was carefully connected to the plug by means of some extra heavy flexible lamp wire. This finished the pot, and it boiled water in thirty minutes. Next a "cooking mat" was made by weaving the same amount of wire back and forth across a surface 6 ins. long, making a mat about ten inches long. The wires were fixed by placing short pieces of asbestos twine between them, painting the whole with asphaltum, and then the whole was stitched in a sewing machine, a number of seams being run about 1 in. apart, all across the body of the mat, which, I should have stated, was built up on a foundation of asbestos cloth, and covered on top with the same material.

By placing a dish flat on this mat, cooking could be done very quickly. The coffee pot, with its own coil, if placed on the mat, would come to time in a hurry. Next we made what for the want of a better name we called a "boiler." Forty feet more of the resistance wire was put on a braiding machine and carefully insulated with asbestos thread. A nickel plated brass tube, 3 ft. long and ½ in. internal diameter, was obtained, and the wire doubled into twenty lengths of 2 ft. each, was drawn into the middle of the tube. After testing for short circuits and grounds, the tube was coiled up into a double circle a little over 3 ins. in diameter.

The ends of the tube were turned up at right angles, so as to project above the liquid when the coil was in use inside of a can or other dish. After plugging the ends of the tube, we had a machine which could be put right into any dish, and water boiled—a quart or so—in five or six minutes.

A separate plug connection is necessary for each of these cookers, and be sure to have the city inspector look them over before you use them. I know of hardly anything which will so thoroughly demoralize an insurance policy as the unauthorized use of electric cooking connections. Above all, never connect any appliance of this kind to a lamp socket. That is forbidden under any circumstances.

George Eastlake.

New Brighton, Staten Island.

Some Electrical Sport.

To the Editor of American Electrician:

Since the last writing, I have been looking around the countrty in search of various things of interest, and incidentally have now and then come across bits of "Electrical Sport" which I have duly "salted down" for "The Electrician." One concern was troubled by the depredations of a certain very little dog which persisted in dodging into the station every chance it could get, and after nosing out a lunch belonging to one of the men, would bolt for the door, taking the lunch with him, to the great disgust of the man whose dinner it chanced to be. Many a time was this trick played by the dog, and no amount of hiding the packages, or placing them in inaccessible places, would discourage the persistent rascal.

For hours he would lie in the sun, apparently asleep, but waiting for all the conditions to be favorable for a visit to the lunch corner. When everybody was busy, and had forgotten dogs and lunches, he would steal in, and somebody's lunch was sure to go with him when he went out. Finally, a trap was laid, and he got caught. A nice juicy bone was procured and laid where the lunches usually were placed. A copper wire—No. 28—was wound around the meat, the insulation having been removed for a few feet at the end, so as to make a good contact with the meat. The wire was then coiled loosely, as it came from the reel, and laid on the floor near by, the other end of the coil being carried to the switchboard, and made fast to the lead of a live arc light circuit. The ground just outside of the station was kept well wet to get rid of the dust. The next time that dog came lunch hunting, he spied the meat bone the first thing, as even its odor was plainly visible with one's eyes shut. He grabbed the bone, and made a bolt for the door, the wire uncoiling as he ran. Just as he got out of doors, the fun commenced. There was a good deal of static charge accumulated on the arc line, and the dog got the benefit of that, also all of the leakage caused by grounds and poor insulation. At any rate, the dog went into the air with a yelp, and as he came down again, and the current cramped his jaws more closely to the meat, he cut capers and did stunts with himself all over the sidewalk.

Finally, with a grand effort, he leaped into the air, broke the wire, dropped the bone, and fled. And never, as long as I knew the place, could that dog be induced to set foot in the station again. The lunches were safe.

George Eastlake.

New Brighton, Staten Island.

ELECTRICA CATECHIS

230. How can one tell whether a wire will be attracted or repelled in a given case?

The general rule is that (a) the lines of force are considered as coming from the North pole and going into the South pole, (b) the lines of force around the current are in the direction of motion of the hands of a clock when one looks in the direction in which the current is considered as flowing, and (c) the effect of bringing two magnetic forces together is to strengthen the field where the two forces are in the same direction and to weaken it where they are in opposite directions, and (d) that the lines tend to separate so as to make the field of uniform strength. It is easier for some to remember the "rule of thumb" for the motor or dynamo.

231. What is a rule of thumb for remembering the direction of pull on a wire?

It is similar to that for the e.m.f. of a dynamo, except that the left hand is taken instead of the right hand. Spread out the thumb and first and second fingers, so that all stand at right angles to one another. Let the forefinger represent the direction of the lines of force, the center finger the direction of the current and the thumb the

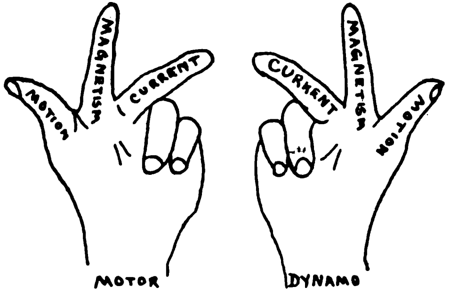


FIG. 1.—RULE OF THUMB.

direction of the motion. Then, if one knows any two, he can easily get the direction of the other. The fingers of the right hand may be remembered as for the dynamo and the left for the motor, since the right hand usually comes before the left and the dynamo must work before the motor will start. Fig. 1 shows it all.

232. What instruments are developed from the force between a current and a magnetic field?

The large class of instruments using permanent magnets, also many using electro-magnets. Many of these are simply portable forms of d'Arsonval galvanometers.

233. What is the d'Arsonval galvanometer?

It consists of a coil suspended between the poles of a magnet so that it may rotate through a small angle when current passes. Fig. 2 shows a simple form arranged for fastening to a wall. The coil is suspended by a small flat wire which forms one terminal of the coil, the connection with the other terminal being made through a very weak spiral spring below. The coil carries a pointer that moves across the scale for reading large deflections. A mirror also fastened to the coil allows the use of a telescope and scale for reading very small deflections of the coil caused by correspondingly small currents. The cylindrical piece of iron in the center of the coil is stationary, and simply serves to better the magnetic circuit, and so make the field stronger than it would be if the whole space between the poles consisted of non-magnetic material, such as air.

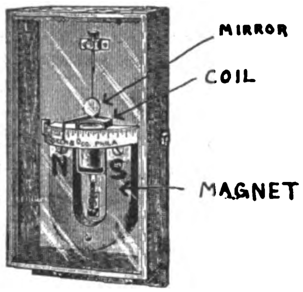


FIG. 2.—D'ARSONVAL GALVANOMETER.

234. What instruments are developments of the d'Arsonval galvanometer?

Those best known are the Weston ammeters and voltmeters, in which the moving coil is supported between jeweled bearings, the current being taken into and out of the coil by means of delicate hair springs, which also serve as controlling springs to balance the deflecting force of the current in the coil. The "heart" of the instrument is shown in Fig. 3, in which parts of the magnet and polepiece are cut away to show the moving coil, the central soft iron core, the two springs and the pivots.

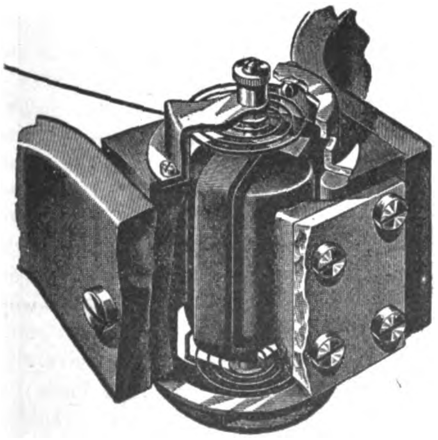


FIG. 3.—WESTON MECHANISM.

235. Do not the currents in the two sides of the coil go in opposite directions and so oppose each other?

The currents are in opposite directions, going up on one side and down on the other. The result is that one side is pulled toward the observer, while the other is pushed away. But both pull and push tend to rotate the coil in the same direction about its center, and so work together to give the deflection.

QUERIES AND ANSWERS

Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied. The privilege of this department only extends to subscribers, and queries must be accompanied by name and address to secure attention.

How may a commutator be repaired in which the insulation between the segments has been partially destroyed near the surface?—E. P. H.

Clean the burnt portion carefully of all copper and carbon dust, and then fill with a mixture of finely powdered mica and melted sealing wax, using as little sealing wax as will make a solid mixture.

Can I run a 125-cycle fan motor on a 60-cycle circuit? If so, how?—T. L. D.

The motor will not run satisfactorily on a 60-cycle circuit. It may be made to operate after a fashion by means of a choke coil in series with the motor. Without the choke coil, it will probably burn out.

Can compound machines be operated in multiple with shunt machines? If so, how? —J. R. L.

They cannot. It may be possible to run them for a short time on a steady load, but it will be in the nature of a feat. The voltage of the compound machine rises as the load comes on; the voltage of the shunt machine falls, and this tends to make the former motor the latter, unless rheostats are narrowly watched. The best way is to cut out the compound coils and run all the machines as simple shunt dynamos.

I have an induction coil which works in a satisfactory manner when the regulating tube is clear in the coil, but as the tube is drawn out the vibrator weakens, and when it is almost out the vibrator stops.—L. F.

The tube acts as a closed secondary coil and allows more magnetizing current to flow in the primary circuit, thus causing the vibrator to operate. When it is withdrawn the magnetizing current weakens and the vibrator fails. A stronger battery is the remedy.

1. What is the meaning of the term "charcoal iron?" How is it made, and how does the term originate? 2. Does it make any difference whether wrought or cast iron is used in the construction of field magnets?—H. C. B. and A. V.

Charcoal iron is simply wrought iron made with charcoal for fuel. It is specified in many cases where the quality of the iron would be damaged for the purpose in hand by absorbing impurities contained in other fuels. If wrought iron is used in a field magnet, about one-half the sectional area will be required that is necessary if cast iron be used.

I am having trouble with a Westinghouse shunt box system, working on 1100 volts, with 20 and 55-volt lamps on one circuit. Lamps in certain localities keep burning out, while other similar circuits give us no trouble. We have renewed the lamps, and even the shunt box in the troublesome localities, but that seems to do no good. The lamps that burn out burn very brilliantly while they last.—V. M.

The trouble is probably not in the lamp or shunt box which burned out, but in the other shunt boxes on the same circuit. The effect of a disabled shunt box would be to dim the lamp with which it is in multiple and to make other lamps on the same circuit extraordinarily bright.

I have three gravity cells in series, operating a closed circuit burglar alarm. They last about four months. If I were to add three similar cells to the system, would the whole set last longer? How should they be connected?—H. B. Q.

If the voltage of three cells is sufficient to operate your burglar alarm, the proper way to add cells to the system is to connect them in multiple. If more cells are added connected in series, the current in the system will be stronger and the cells will run down even quicker than before. Six cells will, of course, last longer than three, though not necessarily twice as long.

What is the method of movement for finding the combined weight of lengths of bare wire of different gages? C. H. K.

Multiply each length by the circular mils, add the product, and divide the sum by the circular mils of a wire whose weight per foot is known. For example, suppose there are 500 ft. of No. 1, 820 ft. of No. 4, 325 ft. of No. 8 and 1620 ft. of No. 14. The aggregate feet-circular mils will be found to be 87,910,590. The circular mils of No. 0000 wire are 211,600, so that the above is equivalent to 415 ft. of this wire, which, at .64 lbs. per ft., will weigh 265 lbs.

We are using a test circuit in our construction department, which consists of two leads from 250-volt mains, including in series four 50-volt 16 c. p. incandescent lamps. What is the voltage between the free ends of the circuit?—H. B.

The voltage between the free ends depends upon the resistance in the circuit across them. If the resistance is very high, such as a voltmeter or the human body, the potential difference will be practically the full 250 volts. As resistance between the ends is diminished the lamps take up more and more of the potential difference until finally, when the two ends are short circuited, there is no voltage between them and 250 volts on the lamps.

1. Is there a process by which the carbons of a simple battery—for instance, the Laclede—can be renewed after being polarized by use?

2. Is there a practical way of refilling or renewing the porous cup of a Le Clanche battery?—W. L. B.

1. The simple carbon is practically indestructible when used for the positive electrode of the battery. If polarized, give it a thorough scalding in boiling water and dry it in the hot sun or by strong artificial heat.

2. The mixture in the porous cups of sal ammoniac cells is frequently composed of equal parts of pounded carbon and black oxide of manganese. Melt the pitch off from the top of the porous cup, pull out the center carbon, empty out the old mixture, repack with new and reseal.

In the operation of shutting down an arc machine, why does not the armature burn out when short circuited?—P. H. P.

The arc machine has its fields connected in series with its armature, and if the latter is short circuited the current is practically cut out of the fields, thus preventing currents of any magnitude being generated in the armature. Some arc machines shut down by short circuiting the field. Short circuiting the armature, however, more promptly deprives the machine of its voltage, for the reason that a momentary flush of current in the armature tends to rapidly demagnetize the field. Either method is good.

What length of No. 22 German silver wire, carrying about five amps., will be required to heat an electric soldering iron on a 500-volt circuit? Would it be better to connect two or three irons in series?—F. D.

The amount of current necessarily depends upon the size of the iron. One to two hundred watts will heat an iron weighing three-fourths of a pound. If you wish to use No. 22 German silver wire and a voltage of 500, you will need about 1250 ohms, which will be in the neighborhood of 3000 ft., according to the specific resistance of the wire you use. No. 22 wire would be too large for such a voltage, as the coil would be bulky and weigh considerably over 4 lbs. One thousand feet of No. 27 would give the same heat and weigh much less. It is not convenient to connect the irons in series, as all of them would be heated when perhaps but one was to be used.

1. Can I wind a one-quarter h.p. 110-volt direct current motor as a rotary transformer to give 7200 alternations per minute?

2. Could I get a storage battery of six volts and 1250 or 625 amp. hours in 6 sq. ft. of floor space?

3. What resistance has a series wound, 110-volt, 1 h.p. motor, and what size wire is it wound with?—F. B. D.

1. Any direct current, constant potential dynamo frame can be wound as a rotary transformer. In your case, however, the motor is probably bi-polar and has to make one complete revolution per cycle or 7200 per minute, which is a dangerous speed for such a machine.

2. No.

3. Such a motor would probably have a resistance of about three ohms. It would probably be wound with about No. 18 wire on the field magnets and No. 21 wire on the armature, but that would be determined by the design of the machine.

What is the actual candle-power of a 2000-c.p. (nominal) arc lamp? J. K.

A test made at the Antwerp Electrical Exhibition on a lamp using 10 amps. and having 45.5 volts between its terminals showed a maximum c.p. of 2070, which corresponds to the nominal rating; a horizontal c.p. of 421; a lower hemispherical mean c.p. of 640, and an upper hemispherical mean c.p. of 102. The total mean or actual c.p. was thus 742, and the useful c.p. 640. Other tests have given a lower figure for the mean or actual c.p.; the quality of carbon, length of arc and shape of crater influenclength of arc and shape of crater influencing the same. The National Electric Light Association has defined a nominal 2000-c.p. lamp as one consuming 450 watts between terminals.

Can a magnet be made with a hollow iron core, which will sustain an iron rod on the inside weighing about 4 or 5 lbs.? What should be the size and weight of the iron core, and how much wire should it be wound with for 100 volts?—W. L. T.

If the magnet be made with a hollow iron core, there will be little if any magnetic pull in the interior of the tube, if the latter is at all thick, although the ends of the tube would probably be strongly magnetic. The better way is to encase the outer parts of the coil with iron and use a brass tube for the center. For a hundred volt circuit the coil should be wound with No. 30 wire, B & S, and each coil should contain at least 1½ lbs. If properly designed, such a coil may be made to hold a weight of 15 to 20 lbs. attached to its plunger. The diameter of the inner tube may be three-fourths of an in.; its length about 5 ins.; the outer iron casing can be conveniently made of 2½-in. gas pipe, and the heads can be made of cast iron.

1. I am having trouble with a double motor equipment. One of the commutators blisters badly, and sometimes connects the segments all together, thereby short circuiting them. I first laid the trouble to weak fields, but find that even with new field coils it still persists.

2. What are the dimensions on a spark coil for gas lighting?—E. P. H.

1. The reason probably exists in the fact that the load divides unequally between the motors. It is easily possible for a field to be weak and yet the field coils be in perfect condition, either by reason of a difference in the quality of the steel of which the casing is made or because the casing is not tightly closed. An ammeter placed in the circuit of each motor will detect this trouble, if it exists; and its magnitude. If there was trouble with the resistance coils on the car it would affect both motors. It is possible also that you have armatures which look alike, but in reality are differently wound. Very frequently manufacturers supply railway motors with different numbers of turns per bobbin on the armature, according to the work that they have to perform, and in other respects the machines will be identical.

2. Core 8 ins. long; ¾ in. in diameter. Outside diameter of finished coil, 2¼ ins. Wind with No. 18 annunciator wire.

1. Is it necessary to use lead for the negative grids of a storage battery? Might not some light metal be used?

2. What is the average life of a storage battery and the deterioration percentage each year?

3. What prevents the battery reacting upon the charging current when the voltage of the latter is reduced? Directions have been given by storage battery people, saying: "The initial charge should be about one-third of the normal rating for four hours, then increase to normal current, which should continue for twenty consecutive hours, or until the positive plates are of a dark brown color and the voltage is 2.6 volts per cell. Drop the charging current gradually to one-fourth and continue until 2.6 volts is reached."

Will not a storage battery discharge through charging circuit as soon as the voltage is reduced to one-third that of the rated voltage of the storage cell?

4. Why is there a loss of at least 25 per cent in a quick discharge of a storage battery?

6. What would be the effect on a battery if the charging voltage was more than two and one-half?—C. H.

1. It is not necessary to have lead grids. Several other materials have been used, both in this country and in Europe; mostly alloys of lead. The main reason for the universal use of lead is that no other metal except gold will withstand the action of the electrolyte during the charge, and gold, even if cheap, is much heavier than lead. Common metals are out of the question, as their presence in solution in the electrolyte is injurious and their structure is soon destroyed. Aluminum on a negative grid may endure for a considerable time, but in the positive grid a few hours' charging will frequently serve to completely dissolve it. Non-metallic grids have been used, simply supporting active material in intimate contact with the conductor, which need only be sufficiently heavy to convey the current properly.

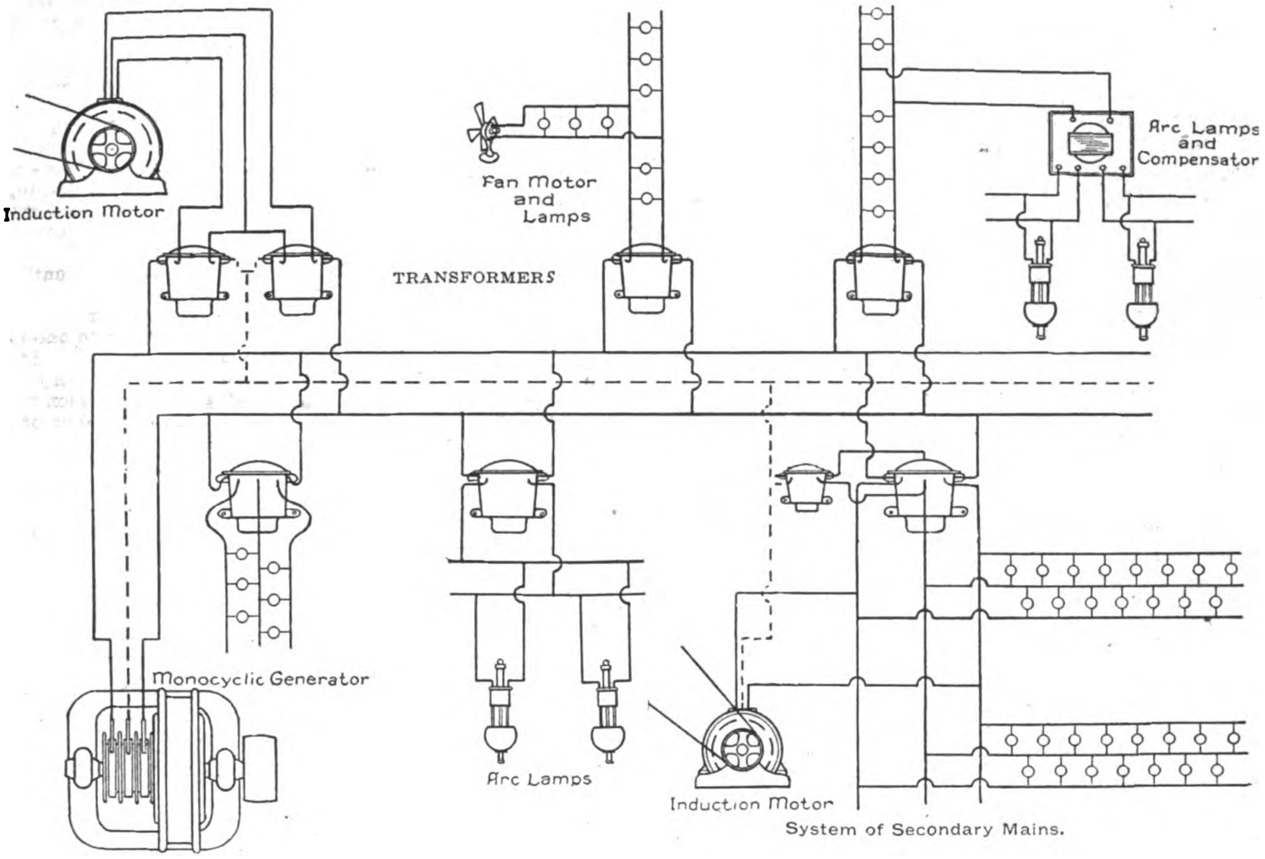
2. This depends entirely upon the service the cell performs and upon the type of cell. The yearly depreciation is as high as 10 per cent in some classes of work.

3. You have confused current and voltage. It is the current that should be reduced to one-third of the normal rating for four hours and then increased as per directions, and the charging voltage should be adjusted so as to give the current the proper values. The battery will certainly discharge into the charging circuit if the voltage of the latter falls below that of the batteries.

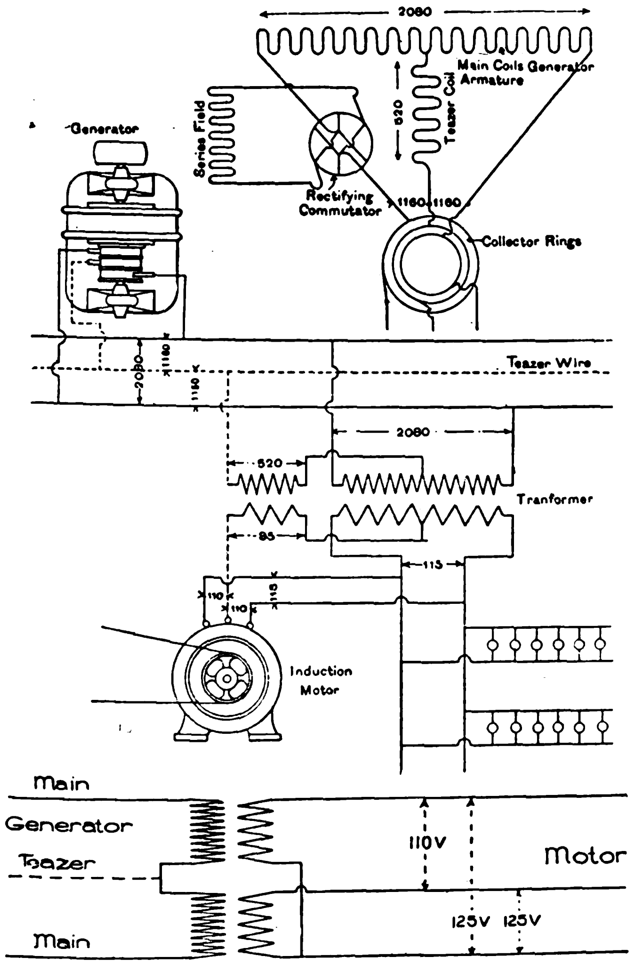
4. It takes time for the electrolyte to become diffused through the active material and, as the chemical action goes on in the interior of the active material, it is necessary to supply fresh fluid at the points where the action is taking place. A cell that has been exhausted at a high rate of discharge, after resting for a while, will give a considerable current at a low rate.

5. If the voltage was raised above 2.5, the charging current would be likely to become excessive, liberating gases rapidly within the plates and causing them to warp and buckle. The charging voltage must be manipulated very carefully. A very slight increase frequently largely alters the charging current.

POLYPHASE ALTERNATING CURRENT CONNECTIONS.


Induction Motor
Fan Motor and Lamps
Arc Lamps and Compensator
TRANSFORMERS
Monocyclic Generator
Arc Lamps
Induction Motor
System of Secondary Mains.

Monocyclic Distribution.


2080
Main Coils Generator Armature
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520
Tranformer
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110V
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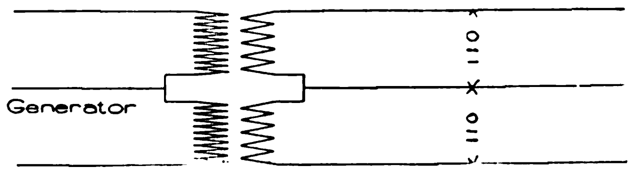
Monocyclic Armature and Transformer Connections.


Generator
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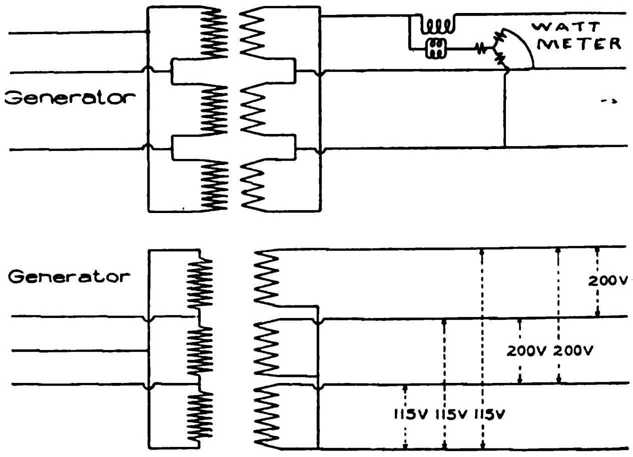
Two-Phase Transformer Connections.


WATT METER
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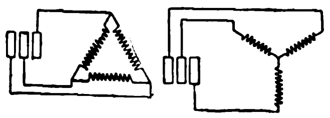
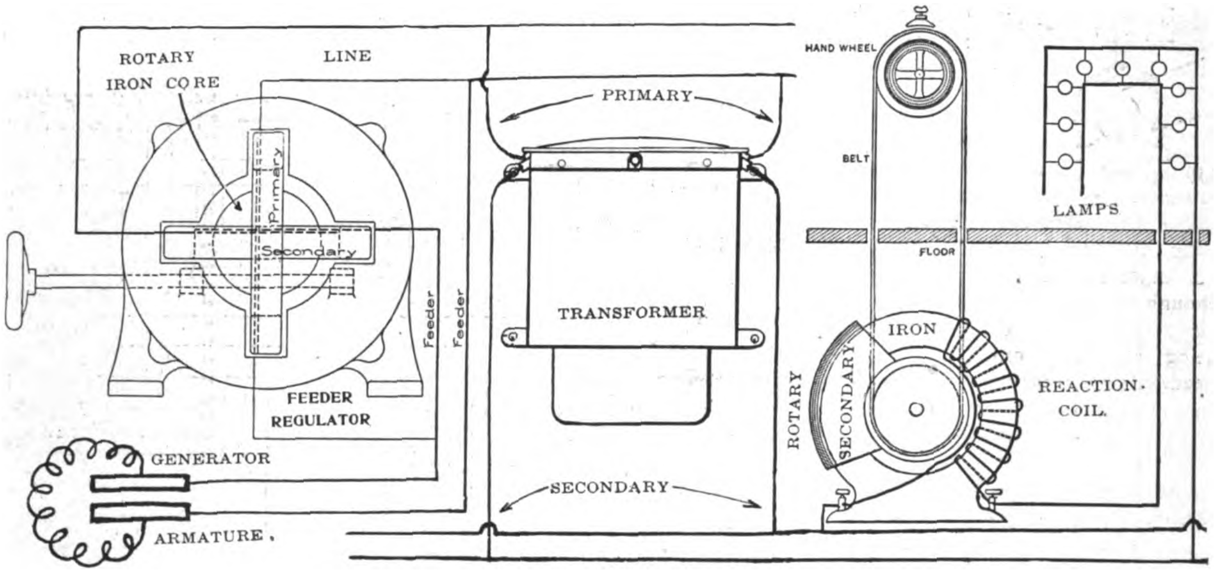
Three-Phase Transformer Connections.



Delta and Star Three-Phase Armatures.

ALTERNATING CURRENT CONNECTIONS.


ROTARY
IRON CORE
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FEEDER
REGULATOR
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ARMATURE
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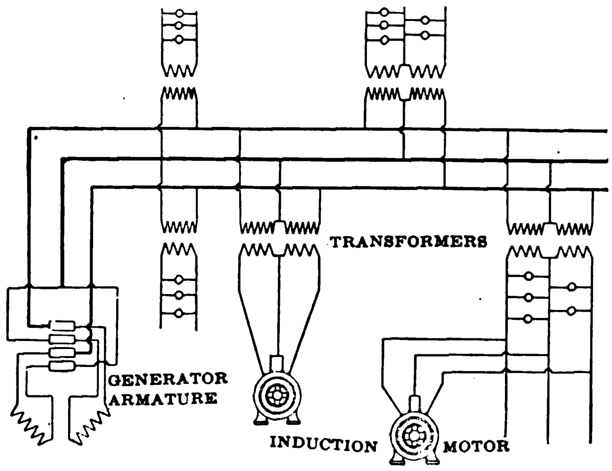
TRANSFORMER
SECONDARY
HAND WHEEL
BELT
FLOOR
IRON
SECONDARY
ROTARY
LAMPS
REACTION
COIL

Reaction Regulators.


TRANSFORMERS
GENERATOR
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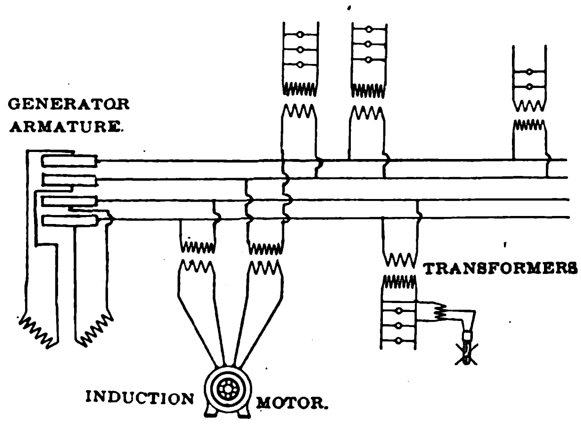
MOTOR

Two-Phase, Three-Wire Distribution.


GENERATOR
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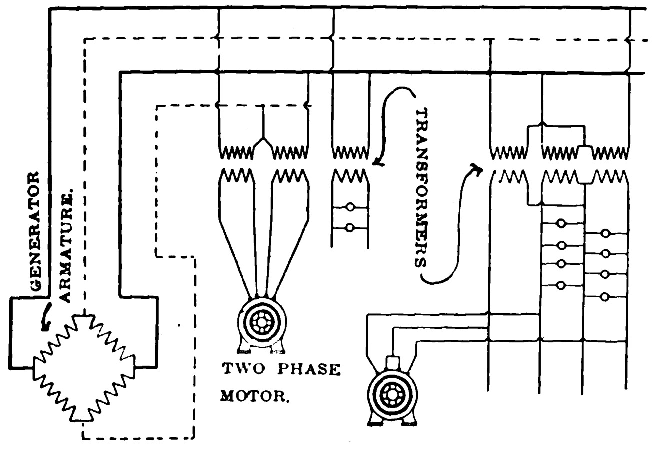
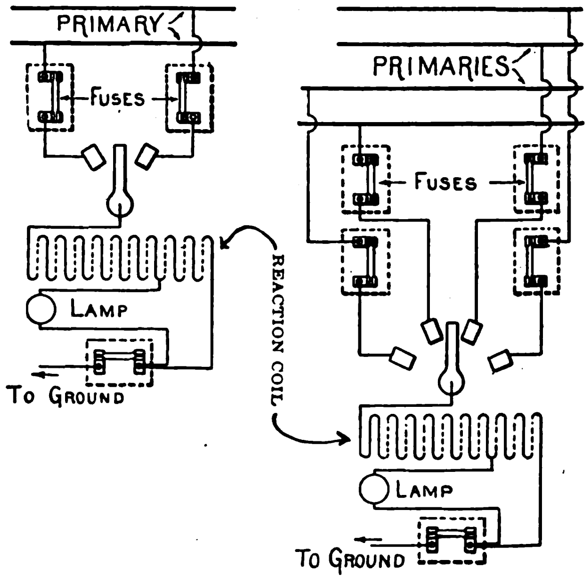
TRANSFORMERS
INDUCTION
MOTOR

Two-Phase, Four-Wire Distribution.


GENERATOR
ARMATURE
TRANSFORMERS
TWO PHASE
MOTOR

Two-Phase Distribution, Two Power Wires.


PRIMARY
Fuses
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REACTION COIL
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Lamp
To Ground

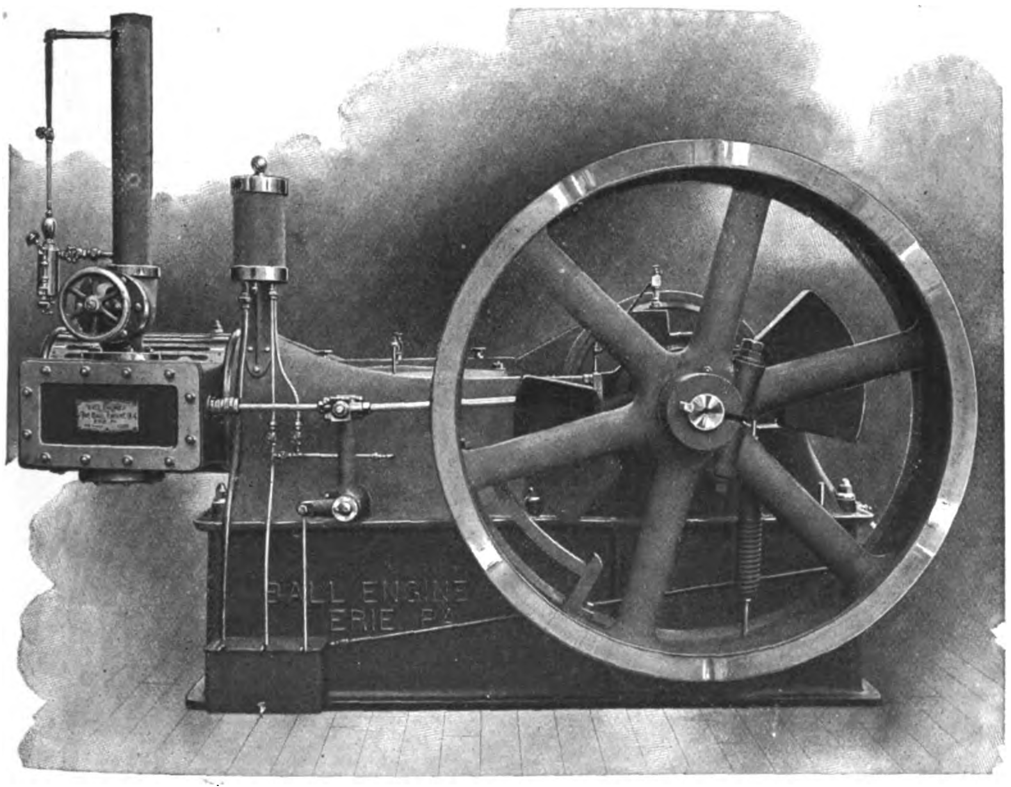
Single and Polyphase Alternating Current Ground Detectors.

Apparatus AND Appliances

IMPROVEMENTS IN HIGH SPEED ENGINES.

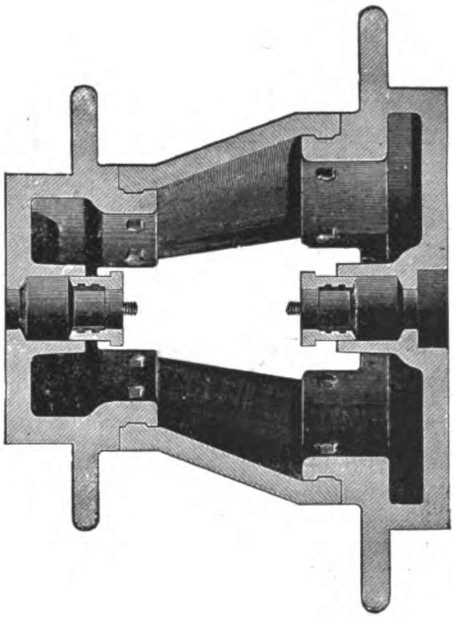
One of the most recent improvements in the engines of the Ball Engine Company, Erie, Pa., is their new oiling system, which is worthy of special note. The ordinary arrangement of sight feed oil cups, though still preferred by many engineers, is growing out of date, the present plan being to have a common reservoir, which feeds all of the sight drips. In order to make such a system as this entirely automatic the manufacturers have provided two reservoirs, one near the base of the engine, and the other mounted on a suitable pedestal, as shown in the illustration. A lever pivoted to the adjacent rocker arm operates a small pump, which pumps the oil from the drip tank up into the reservoir tank and makes the circulation continuous. A new inertia governor, which was introduced a short time ago, is still being used and has proved a great success.

Another arrangement shown in the illustration is a divided head between the high and low pressure cylinders in tandem compound engines. By means of removing this head access can be had to the low pressure without removing the high pressure cylinder, a distinct advantage in such types. A further advantage in this form of head is that the stresses exerted by the cylinders are taken up by the grooved joints and not by the bolts that hold the head in position.



AUTOMATIC LUBRICATOR FOR HIGH SPEED ENGINE.

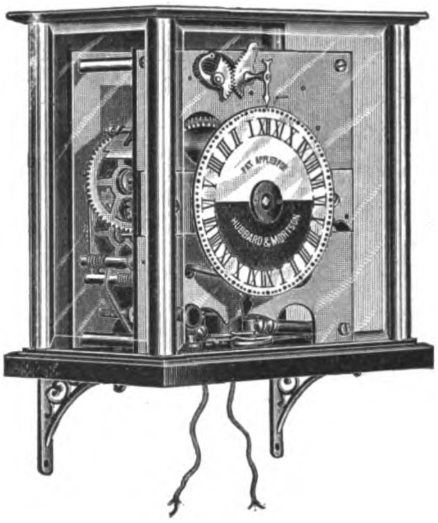
The vertical engines of the company, which a few years ago were comparatively new and untried, have met with great success and are now being extensively advertised and sold. The company's new catalogue contains much interesting technical information concerning the construction of their engines, and those who are interested will do well to write for it, as it is supplied on application.



DIVIDED HEAD BETWEEN CYLINDERS.

AN AUTOMATIC TIME SWITCH.

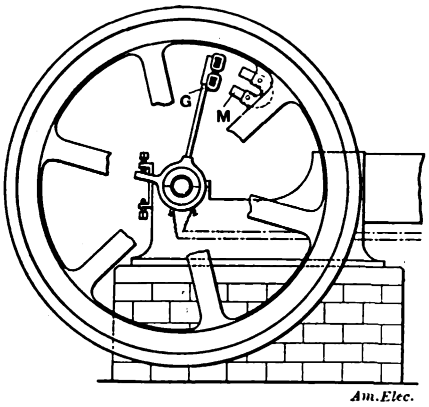
The accompanying illustration depicts an automatic time switch, which will switch on and switch off an electric current at any desired hours. As is shown it is attractive in appearance and an ornament wherever it may be installed. It consists of a powerful train of wheels actuated by a spring and automatically controlled by a clock movement. A twenty-four-hour dial which makes one revolution every day revolves under a fixed pointer at the top of the apparatus, and behind this dial are two movable pointers which are held in position with sufficient friction by the action of a spring disc. These pointers may be set at any time of the day or night, and when set, are fixed rigidly in position by pins which engage in a row of holes parallel with the circumference of the disc. When the first pointer reaches the reading point at the top, the other end trips an alarm wire, which sets in motion the train of gears and turns the switch. After the set time has elapsed, the second pointer approaches the point of reading and sets the train in motion again, turning off the switch. The only attention the switch requires is winding once a week. The installation is very simple, the circuits to be controlled being connected the same as with an ordinary jack-knife switch. Different sizes of switches are put into the clock in accordance with the strength of current it is required to handle. The switch is arranged on a slate base and meets all the requirements of the boards of underwriters in the different States. It is manufactured by the Hubbard & Mortson factory, located at 42 Union Place, Hartford, Conn.



AUTOMATIC TIME SWITCH.

NEW ELECTRIC IGNITER FOR GAS ENGINES.

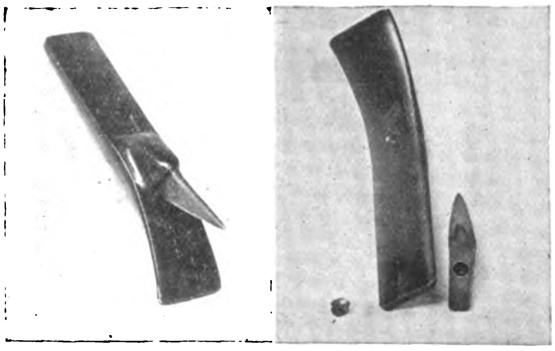
The problem of electric ignition for gas engines has met with a very pretty solution at the hands of the McInnerny Manufacturing Company, Omaha, Neb. The accompanying drawing suffices to show the principle, which is exceedingly ingenious. A generating coil G, suitably provided with a magnetic core, is fastened to an arm which can be varied in its angular position relatively to the fly wheel. The fly wheel carries a powerful magnet, which passes across the face of this coil once every revolution and induces therein a pulse of e.m.f. The arm carrying the generating coil is so set that this pulse occurs coincidentally with the breaking of the contacts in the explosion chamber. The weight of the magnet is 3¼ lbs. and that of the generating coil, including the core, 8 lbs. It will be seen at once that there is no wearing to the generator and there is no reason why it should not outlast the engine. It is said that simply turning the fly wheel over by hand gives sufficient e.m.f. to make a spark that will ignite the charge. The problem of a good electric igniter for gas engines has been a puzzler for electricians of all grades and has been more than once given up in despair. For this reason the device shown and described herewith will prove more than exceptionally interesting for those who have to do with gas engines.



ELECTRIC IGNITER FOR GAS ENGINES.

CLIMBER FOR LINEMEN.

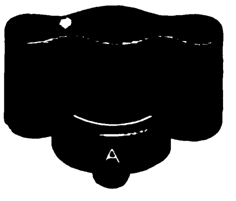
The accompanying illustrations show a new climber recently placed on the market by the Electrical Supply Company of Madison, Wis. The advantage of this climber is the detachable and renewable spur. The frame of the climber is drawn out the proper thickness from either direction of the spur socket, leaving the metal at that locality of the original thickness of the iron. The spur is made of the very best tempered steel by experienced toolmakers and is secured in place by a small set screw, which has no other duty to perform. Linemen will appreciate this specialty, because, in the first place, it ensures a spur of the very best material, and, in the second place, this most destructible part of a pair of climbers is by means of this device readily renewed. A lineman gets accustomed to a certain set of climbers and the breaking in of a new pair is very troublesome, a difficulty which is avoided in the climbers shown.



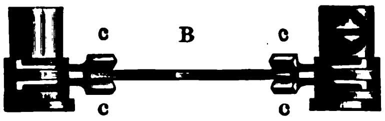
RENEWABLE SPUR FOR CLIMBER.

IEPROVEMENTS IN SNAP SWITCHES.

The Hart & Hegeman Company, Hartford. Conn., call attention to the recent improvements made in their switches, some of which are illustrated here.

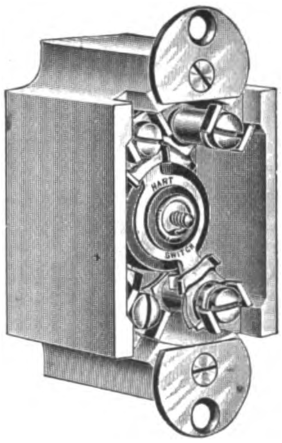


HANDLE WITH SPRING WASHER.



JACK-KNIFE SWITCH JAWS.

A snap switch is capable of being one of the most unsubstantially made articles on the market, although it may for a time perform the work that it has to do, and the thorough construction of the Hart switch will, therefore, be appreciated. The contacts are on the jack-knife plan, as shown in the figure, the connecting plate being forced between plates in precisely the same way as a station knife switch, although on a smaller scale. Another feature obtains in the self-adjusting handle, also illustrated. The collar, A, is movable vertically and is pressed downward by a spring between the body of the handle and the collar itself. When the handle is screwed on the switch, the collar holds the cover in place and the handle can be manipulated without unnecessary friction. The spring is incased within the collar and is invisible. The Hart switches are made in many different forms, one of the most popular being the flush switch, shown in the accompanying figure. These switches are made in many types, but this particular one is very suitable for use in confined quarters, as its dimensions are only 2 13-16 x 1 11-16, the depth being 1½ ins. The switches are all indicating, showing at a glance whether they are on or off.



COMPACT FLUSH SWITCH.

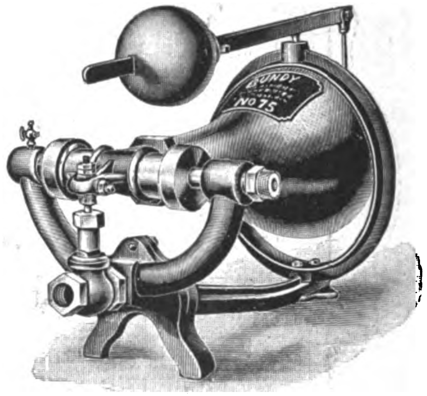
Electricians will be interested to know that the Hart & Hegeman Company is prepared to supply these switches in three and four point types, which are exceedingly useful in many cases and often indispensable. It is hardly necessary to mention that the switches are also supplied in gangs of any number with a single cover plate. These gang switches are of the flush type and frequently do away with the troublesome necessity of a cabinet. Special finishes will be furnished when required.

The company also announces the production of a 500-volt switch, which they claim to be fully equal to the severe requirements of the 500-volt service. This information will be of interest to railway officials, who frequently have to use power-house currents in lighting car barns and stations.

The reputation of Hart & Hegeman goods is well and favorably known, and it is to be assumed that these specialties will be received with the same favor that has been accorded the goods they have been previously making.

AN IMPROVED STEAM TRAP.

The high pressure tank steam trap, known as the Bundy, and illustrated herewith, is designed for draining receivers, reheating coils, cylinder jackets on compound engines, separators and the like—in fact, any apparatus working under extremely high pressure. It is constructed for use under as high a pressure as 250 lbs. to the sq. in. The valves are fitted with specially devised discs, and their opening and closing is independent of the pressure. The trunnion stuffing boxes are packed with a specially prepared spiral packing, and if the pressure on this packing is adjusted while the trap is hot it will not leak under any pressure. The actuating power of the trap is gravity. The bulb shaped tank fills with condensation, and the added weight causes it to fall, which opens the valves and allows the tank to empty. The weight of the top of the trap is heavier and lifts the tank, thereby actuating the valves again and reconnecting it to the high pressure system. The trap is tested by 300 lbs. of live steam pressure. Its

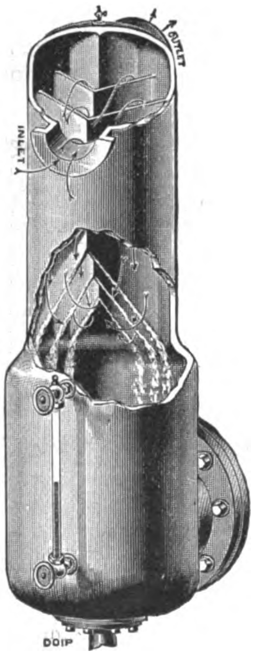


STEAM TRAP.

principle is simple and its makers have aimed to make its construction such that it will be classed among the highest grade of steam specialties. This trap is manufactured by the A. A. Griffing Iron Company, Jersey City, N. J.

A STEAM SEPARATOR.

The Curtis separator herewith described is unique in the fact that it combines a steam separator and steam trap. The principle upon which the separator operates is the well known method of causing the steam to quickly turn a sharp corner in a suitable receptacle and the entrained water is thrown off and projected against the inclined faces of a deflector. The particles gather together in a stream against the back of the separator and flow downward toward the base. The deflector plates are so arranged that the drops and streams of water and grease cling to the plate until they reach a point of contact with the shell, and in that position, as they are entirely out of the steam current, they flow quietly to the bottom of the separator. The steam passes through this operation twice, and thus any entrained matter which has escaped the separating action of the first turn is thrown out in the second and showers down as a fine spray against the sides of the shell. The water in the base is removed by the Curtis patent balanced float trap. The valve is double seated and balanced and therefore independent of pressure. The float is made of composition and is perfectly rounded and guaranteed up to 150 lbs. pressure. A by-pass valve is provided whereby the entire contents of the separator can be blown out at will. A grease cock is placed just below the water line of the trap and the grease, which is lighter than water, is drawn off at intervals. The water itself is trapped off and the sediment which sinks to the bottom of the apparatus can be occasionally removed as it accumulates by taking off the cover, which removes the float and exposes the interior for inspection. This apparatus is manufactured by the D'Este & Seeley Company, Boston, Mass.



STEAM SEPARATOR.

A NEW BELT DRESSING.

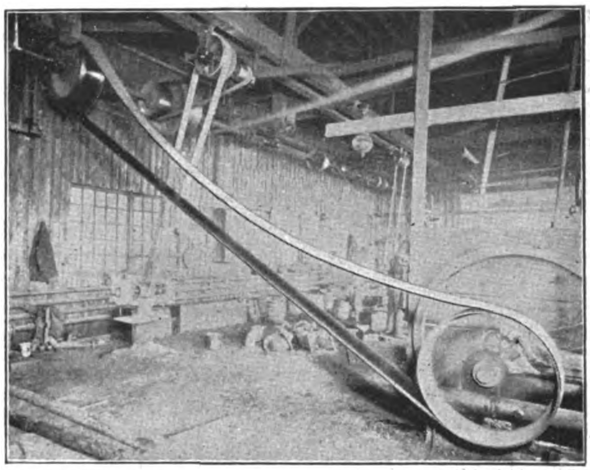
Many station managers derive excellent results from the use of belt dressings, one of the latest of which to be placed on the market is that known as "Cling-Surface," manufactured by the Cling-Surface Manufacturing Company, Buffalo, N. Y. The theory upon which this dressing derives its efficacy is as follows: Leather, which constitutes two-thirds of the belting material, is composed of interlacing fibres which are commonly dry. As the belt in use bends over the pulley these fibres are constantly rubbing together, producing friction that after a time wears out some of the fibres. The leather becomes weakened in spots and the belt cracks. Again, the belt is stiff and hard, its wearing surface becomes polished, and, as it does not conform to the pulley face, it slips. To "save time" it is often taken up as short as possible, which increases the strain on the belt, the friction on the bearings, and also wears the metal.

The same is believed to hold good in a measure with a cotton belt. In a rope drive the friction is between the strands, augmented by the fact that they are hard twisted.

A good rubber belt ought to cling, but in some instances it is found that it clings for a short time only, when the belt takes on a gloss and requires something to make it pull.

The stitched and painted cotton belts are good drivers for a time, but is stated that they also take on polish and slip. As the result of repeated tests it is claimed that a patent leather belt will transmit the most power, for the reason that it is thin and soft and conforms to the pulley; that the surface being perfectly smooth and dry, no dust adheres to it and consequently it lies flat, with no air between it and the pulley face; also that the patent leather surface clings to the face of the pulley without sticking.

In Cling-Surface the inventor claims he has a material that will produce and retain this patent leather effect, and more, on a new or an old leather belt, on cotton, on rope, or on a rubber belt. He states that when this dressing is applied to a leather belt it should be melted and a very thin coating laid on with a brush every day or two until the belt is full; that as a result of this process the fibrous leather becomes filled with a neutral hydro-carbon that will not oxidize like a grease or evaporate like an oil; consequently it will remain in the belt surrounding and lubricating the fibers as if they were resting in an oil bearing.



BELT USING "CLING SURFACE" DRESSING.

The manufacturers of the dressing claim that a belt treated in this way cannot crack, and that it will last almost a lifetime; that it is as soft almost as a piece of cloth, and yet it will not stretch; that the soft, spongy portions of the belt are filled and become solid and firm, yet flexible; that it is absolutely waterproof, and if immersed in water for two years it will not become hard; also that it is oil proof, for if an oily belt is treated on the inner side with this dressing the oil will be driven out and can be wiped off, while the Cling-Surface will take its place.

It is stated that while this transformation is taking place in the belt, a clinging surface is being produced on its surface, so much like the patent leather surface as it is possible to produce and retain on an oily background. This surface is smooth and even. It is neither sticky nor smeary, and yet it is very clinging; so much so that slipping is impossible with such a belt, and it can run slack as shown in the illustration herewith of one of the company's bells, which, it is said, had no dressing on it for two months previous to the taking of the photograph.

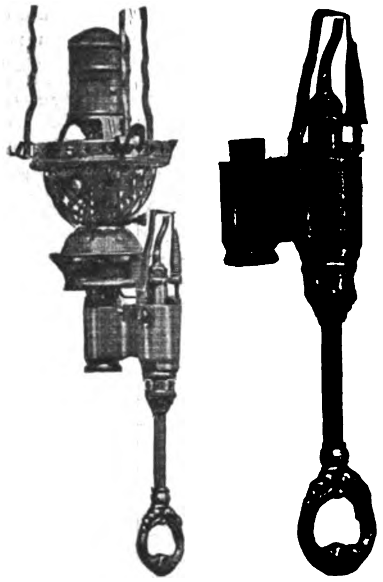
When a belt is full of the dressing it can hold no more, so that only enough is necessary thereafter to keep the surface from getting dry.

The company states that cotton belts and rope drives are treated in the same manner, but as this inner treatment is not necessary with a rubber belt, the Cling-Surface on the latter must be laid on thinly and not so often applied.

The Cling-Surface Company states that the assistant superintendent of the Erie Railway Dry Dock says that by the use of this dressing "We believe we have saved the cost of taking up 500 belts in the past two and a half years."

ELECTRIC GAS LIGHTING ATTACHMENT.

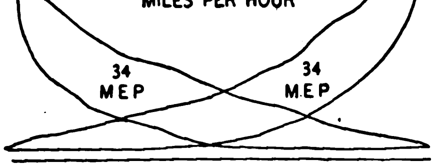
We illustrate herewith one of the specialties known as the American gas lighting attachments for Welsbach burners, manufactured by the Bibber-White Company, of Boston, which has recently purchased the business of the American Electric Company of that city. These attachments are claimed to be of exceptionally good design, and none but the best material and workmanship are employed in their construction, which guarantees good results to the users. The company will continue to produce the various specialties manufactured by the American Company, including the New Era and Victor burners, so favorably known to the trade.



GAS LIGHTING ATTACHMENTS.

AN INTERESTING INDICATOR CARD.

The accompanying cut shows an indicator card taken from a locomotive traveling at the rate of seventy-eight miles per hour. It speaks well for the indicator which took the diagram, for the conditions at the top of a locomotive cylinder running at that speed are particularly arduous.

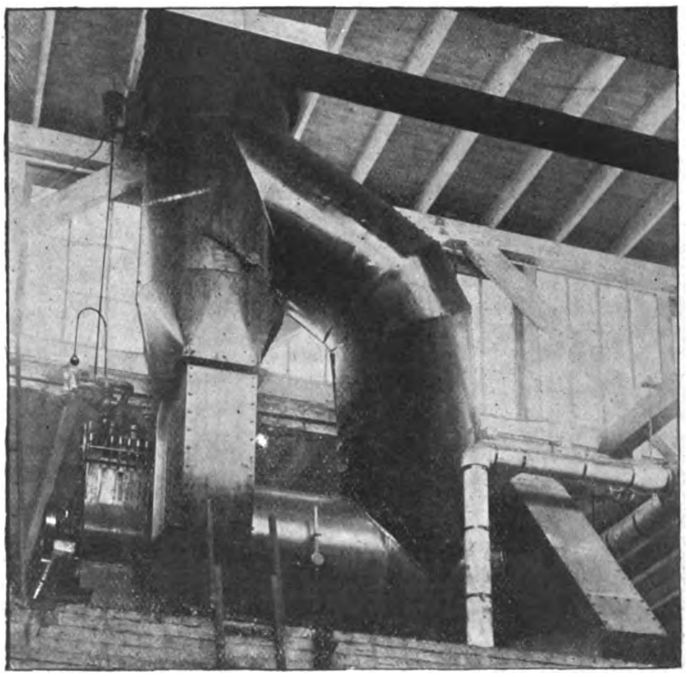


INDICATOR CARD.

The fierce wind, the flapping of the indicator cord and the vibrations all tend to make the diagrams exceedingly irregular, and these appear remarkably smooth. These diagrams were taken by a Robertson-Thompson indicator, made by the Robertson Manufacturing Company, New York. Part of the secret of the easy management of this indicator is in the detent arrangement on the drum, which enables the indicator to be started and stopped without unhooking the string on the reducing motion, which is inconvenient at all times and frequently in the nature of a feat with high speed engines. The company also supplies a reducing motion known as the Victor reducing wheel, which has been successfully operated on engines running at 580 r.p.m.

FORCED DRAFT APPARATUS.

In the accompanying illustration is shown a Sturtevant engine and blower as applied to the boiler plant of B. F. Sturtevant & Company, Boston, Mass., the object being to produce forced draft and do away with the necessity of a tall and expensive chimney. The outfit shown is mounted on top of the boilers and supplies a draft for a plant of three boilers having a nominal rating of 260 h.p. The engine is a double upright affair with cylinders 5 x 4, and the fan is a special 90-in. Sturtevant exhauster. The speed of the engine and consequently the intensity of the draft is regulated by a special device, which serves to increase the steam supplied in proportion as the pressure is reduced. It is so adjusted that a decrease of about 1 lb. of the steam pressure varies and changes the speed from minimum to maximum, or vice versa. The boilers use a half and half mixture of Cumberland coal and yard screening, and by means of the fan have been operated at as high a rate of combustion as 21.5 lbs. of coal per sq. ft. of grate surface per hour, and an evaporation of over 11 lbs. of water from and at 212 degs. per pound of combustible has been obtained. Although no economizer was used, the temperature of the gases at the inlet of the fan, when evaporating this amount of water, was only 222.5 degs. These figures are furnished by the Sturtevant Company, who installed the apparatus, and they make very interesting food for reflection as to the advisability of large chimneys in connection with manufacturing plants. Tall chimneys are expensive constructions, and frequently utilize much valuable space, and a little forced draft equipment, such as is shown, occupies much less space and consumes very little power, frequently so little that the interest on the added investment of an equivalent chimney would pay for it.



ENGINE AND BLOWER MOUNTED ON BOILER.

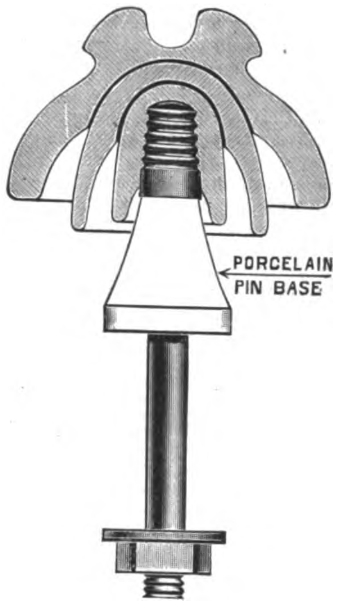
This, however, is not the important engineering feature, which consists in the fact that having the intensity of the draft under complete control, the fireman can admit exactly the right amount of air to secure the best combustion, and can efficiently use cheap fuel in cases where with the ordinary chimney the results would fall short of the requirements. In the plant illustrated, the stack does not extend above the level of the surrounding buildings, and it is stated that no inconvenience has resulted therefrom, that in fact smoke is scarcely ever visible, and then only for an instant, due to the more perfect combustion obtained by means of accurate regulation of the forced draft. It is, further, a well known fact that in order that a chimney must draw well its flue gases must have a reasonably high temperature. It is easy to see that the forced draft is independent of the temperature of the flue gases, and therefore all the heat that they contain could be withdrawn for useful purposes by suitable economizers without in any way interfering with the intensity of the draft.

A MARINE LIGHTING SET.

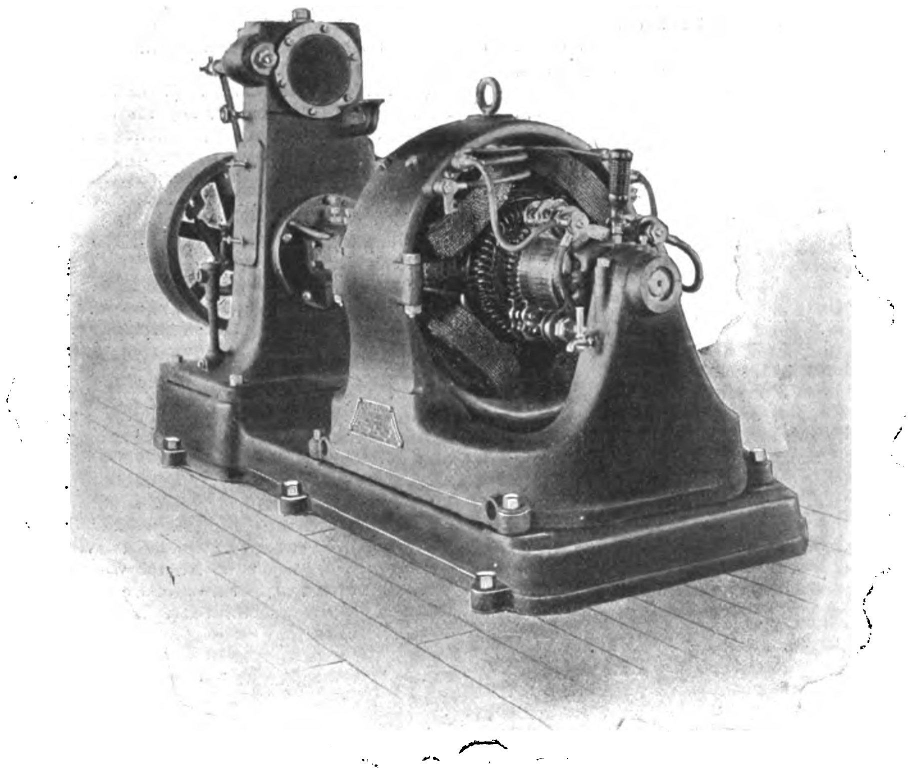
In the accompanying cut is illustrated a Case engine and Keystone dynamo, adapted for a marine outfit. The two machines operate very prettily together and the plant can be placed in many situations where a belted machine would be inadmissable. The outfit illustrated was installed upon a steamer from San Francisco. It is a well-known fact that there are but comparatively few small good upright engines, and also small dynamos are apt to be of poor quality, because they can be made with moderate facilities and small outlay. The apparatus illustrated, however, is an exception to this class. It is strictly high grade throughout. It is particularly adaptable for shipboard work, because of its complete reliability. A breakdown of the lighting plant on shipboard is frequently a serious matter and reliability rather than first cost should be the primal consideration. The engine of this set is manufactured by the New Britain Machine Company, New Britain, Conn., and the dynamo by the Keystone Electric Company, Erie, Pa.

HIGH VOLTAGE LINE INSULATOR.

Illustrated herewith is still another type of insulator, manufactured by Fred M. Locke, of Victor, N. Y., which is intended for high voltage work and is made for potentials from 5000 to 50,000 volts. It consists of three shells of vitrified china fastened together with glaze. The whole is mounted on a steel pin with a porcelain base. There is nothing combustible about either the insulator or the pin and it is impossible, therefore, to burn off the latter by static discharge. A double petticoat insulator of this type was illustrated in the last number of the "American Electrician," but this insulator is adapted for higher voltage and even more arduous duty.



HIGH VOLTAGE LINE INSULATOR.

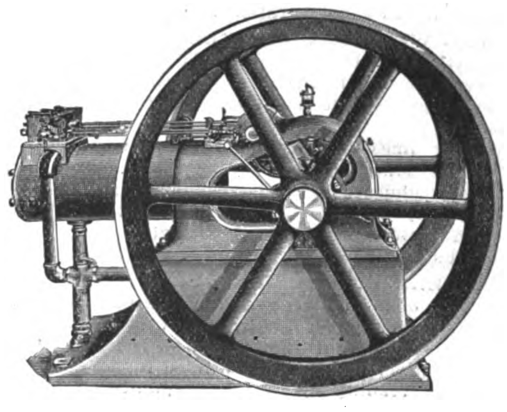


MARINE LIGHTING SET.

AN IMPROVED GAS ENGINE.

The gas and gasoline engine illustrated herewith, possesses a number of features which are worthy of inspection and should meet with approval. The engine shown is a simple, double stroke, four cycle engine. The valve mechanism, as will be noted, is all on top of the engine where it can be easily gotten at. There are three valve rods, two of which are actuated by a cam mounted on a shaft, which is driven by the main shaft in the ratio of 2 to 1. The third rod, which controls the admission of combustible, is actuated by a movement controlled by the governor. The valves are of the mushroom or poppet type and are securely closed by springs.

The manufacturers claim a great deal for their electric igniter. There is no question that the electric igniter is a much superior device, provided that it can be kept in order and always relied upon, for it explodes the charge at the right moment, and without waste of fuel. In many engines, ignited on the hot tube plan, it frequently requires nearly as much gas to run the igniter as to run the engine. The manufacturers have, they state, an automatic arrangement for cleaning the contact points of the igniter temporarily without stopping the engine, thereby obviating the troubles which are certain to ensue from incrusted electrodes, and which have effectually relegated many igniters to the domain of partially successful experiment.



GAS ENGINE.

The engine is adapted to burn any kind of gas without special devices and is provided with an automatic starting device, which saves a great deal of annoyance and enables one man to readily start a 50-h.p. engine.

Another valuable feature of this engine is the fact that it can use as a fuel natural gas, producer gas, manufactured gas or gasolene without any special attachment, and change can be made from one fuel to another without stopping the engine.

The engine is manufactured by the Dayton Globe Iron Works Company, Dayton, Ohio, in whose catalogue are set forth some very flattering tests showing the voltage of dynamo driven by one of their engines on various loads. The catalogue also describes the construction of the engine, and will be sent on application.

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TRADE PUBLICATIONS.

THE ELECTRIC APPLIANCE COMPANY, of Chicago, has issued a very neat circular of electrical house goods specialties for which they are general Western agents, giving particular attention to the Noxall annunciator, showing in detail the construction and operation of the machine, etc. The company will be pleased to send a copy of this special circular and price list to any of the trade who have not received the same.

THE BABCOCK & WILCOX COMPANY, New York, has just issued the thirtieth edition of its book entitled "Steam." This book has been for years one of the standard works on water tube steam boilers and on boiler practice generally. The present edition contains much new matter. It is beautifully printed and illustrated and substantially bound, and is sent free to anyone in any way interested in the generation of steam.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has issued a very neatly illustrated trade catalogue on the subject of the advantages that may be secured by using an electric current instead of long lines of shafting and connecting belts for the transmission of power. The little brochure is carefully compiled and interestingly written. It is replete with excellent half tones of the Westinghouse apparatus and methods.

MODERN ENGINEERING PRACTICE is the title of a circular issued by the Famous Filter Company, St. Louis, Mo., which contains some original information on renewing waste lubricating oil, and will be found interesting reading by all power plant engineers.

MR. WILLIAM ROCHE, the maker of new standard batteries and various other electrical specialties, located at 250 Greenwich Street, New York, has issued a little booklet on his new standard dry battery. As he claims to have made over 1,250,000 cells, he certainly should know something about the business.

EUGENE MUNSELL & COMPANY, Chicago, Ill., are sending to their Western customers a very neat blotter, on which is embossed the Cuban and American flags, under which are the words, "Victorious on Sea and Land!" The printed matter beneath these words refers to the rapid development of the company's business and to the superiority of their "Mica" insulation.

JOHN A. ROEBLING'S SONS COMPANY, Trenton, N. J., who are well and widely known as manufacturers of wire and cables of all kinds, have issued an extensive catalogue of their goods, which exhaustively describes their various products and is supplemented with many valuable tables of data concerning them. The front of the catalogue is devoted to an interestingly written introduction discussing their facilities and the growth thereof. Following this are descriptions of the famous Roebling suspension bridges, among which may be mentioned the Niagara Suspension Bridge, the Allegheny Suspension Bridge, the Ohio Bridge and the well-known Brooklyn Bridge. In this particular field the Roebling Company seems to have been almost without a competitor. The catalogue is handsomely and substantially gotten up and is certainly worthy of the efforts of any interested party to secure it.

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BUSINESS NEWS.

MR. H. A. WAGNER, of the Wagner Electric Manufacturing Company, St. Louis, Mo., has been staying at Asbury Park for some time and transacting a large amount of business between whiles.

THE VULCANIZED FIBRE COMPANY, Wilmington, Del., is sending to its customers samples of its product in the shape of tubes, washers and sheets. This fibre is exceedingly tough and close grained. It is a well-known and valuable material in electrical construction of all kinds.

MR. JOHN A. BRILL, Philadelphia, advises us that, owing to extreme rush of business, he is kept so closely confined to business as to be unable to serve as a director in the General Electric Automobile Company, as was generally given out at the starting of that organization.

THE CUTLER-HAMMER MANUFACTURING COMPANY, of Chicago, since its consolidation with the American Rheostat Company, has been working overtime in order to fill orders promptly, and has more men in its employ than ever before. It has received large foreign orders, and states that if the increase in business continues it will be obliged to seek larger quarters.

MR. A. C. GARRISON, secretary of the Columbia Incandescent Lamp Company, of St. Louis, states that the demand for the Columbia lamps has increased to such an extent during the past year that his company will be obliged to enlarge its factory during August. Orders should be sent to them as early as possible, and thus insure prompt shipment during the next sixty days.

THE OHIO ELECTRIC SPECIALTY MANUFACTURING COMPANY, Troy, Ohio, which has long made a specialty of dynamo and motor brushes, states that the Perfection brush manufactured by it is the result of the ideas of its own inventors and designers, and trust that the trade will avoid the purchase of "all cheap imitations of this type of brush placed on the market by parties claiming to be the designers."

McINTOSH, SEYMOUR & COMPANY, Auburn, N. Y., have recently secured contracts for two 700-h.p. horizontal cross compound engines for direct connection with two 452 k.w. General Electric generators, for trolley work in the City of Mexico. This company has also sold a 150 h.p. engine for use in the Kimberly mines of South Africa, where it will be direct connected to two 60 k.w. generators of the double end plan.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is now placing on the market a solid belt dressing in round bars, about 8 in. long and 2 in. in diameter. It makes a package convenient to the hand and easy to apply, even to fast running belts. The company does not claim that the solid dressing is as good a preservative of the life and elasticity of the leather as the Dixon paste, but it is quick to apply and quick to act, and that is what is wanted by the general run of belt users.

THE WARREN-MEDBERY COMPANY, Sandy Hill, N. Y., has practically completed the addition to its new works, and is now setting up some very heavy machinery, to be used in the construction of its inductor alternators. The company reports the sale of these machines is rapidly increasing, and the works are running to their utmost capacity. The line of knife switches which they are producing is very extensive, and the demand for same is rapidly improving.

THE CENTRAL ELECTRIC COMPANY, of Chicago, is carrying in stock large quantities of wooden and iron pins and brackets and glass insulators. They have considerably augmented their previously large stocks, and are prepared to take orders of any size. The company also has a large and well assorted stock of the celebrated Loricated Conduit for interior wiring, and complete lines of all sizes of circular loom conduit and plain brass and iron armored interior conduit and all fittings.

MR. EDWARD E. CLEMENT has resigned his position of assistant examiner of electricity in the Patent Office and has opened an office for the practice of patent law. He is located at the Magill Building, 908 G Street, Washington, D. C. Having been nearly seven years in the Patent Office, he is in close touch with the department and should experience but little difficulty in serving his clients. His specialty is the electrical field, but he is well qualified to operate in kindred branches.

THE PENBERTHY INJECTOR COMPANY, of Detroit, Mich., reports a very gratifying increase in the sale of injectors for the first half of '98, its sales having increased over 30 per cent during the past six months, and the outlook for a still greater increase before the end of the year is very bright. This gratifying increase in the volume of business is believed to be due to the high grade and excellent reputation of this company's product among steam users.

THE CLEVELAND ELECTRIC COMPANY has recently been organized for the purpose of manufacturing specialties in the way of electrical appliances, with offices at 14 Middle Street, Cleveland, Ohio. The company is fortunate in having secured for its general manager Mr. F. A. Rogers, for many years connected with the Card Electric Company, Mansfield, Ohio, whose many friends wish him every success in his new enterprise. The other officers of the company are W. J. Morgan, president; F. C. McMillin, vice-president; O. P. Fisher, treasurer, and N. C. Stevens, secretary.

THE W. H. ELLIOTT ELECTRIC COMPANY, Cleveland, Ohio, has entered the field of heavy repair work and has exceptional facilities for handling jobs of that character. The business of this company is that of rewinding armatures, fields, transformers; refilling commutators and making new ones; building armatures for all classes of machines and doing experimental work. It is doing an extensive business and has just shipped two large armatures to the Salem Consolidated Company, of Salem, Ore., and is also doing some work for Jacksonville, Fla., and in the meantime it is also securing a large volume of local business.

AN INGENIOUS LINE of fixed and portable pole steps has recently been brought out by Mr. D. B. McBride, of 132 Southwest Temple Street, Salt Lake City, Utah. The portable step is fixed in a socket which is securely screwed to the pole. The step can be detached from the socket and carried in the pocket of the linemen, and enables them to reach the permanent steps above. The sockets weigh eight ounces, each portable step six ounces and the permanent step nine ounces. The fixed step is not a spike, but a screw, and can be removed from the pole at any time and used elsewhere. It is intended to use four portable steps on each pole, and the lineman is supposed to carry the four steps with him. The sockets are rounded and afford no handhold for unauthorized persons to climb the pole.

THE MICA INSULATOR COMPANY, of New York and Chicago, reports a gratifying demand for "Micanite" segments for electric light and power generators, and that some heavy orders are being executed at the factory in Schenectady, N. Y. Many of the large generators now under construction have for their commutator insulation "Micanite," and the heavy increase in the company's business during the last few months is reported to be largely due to the improved process of manufacturing a perfect commutator segment. The company offers to send free to any machinery builder or electrical repair concern a set for any one of the smaller machines free of expense, and solicits correspondence from parties interested in the economical insulation of electrical machinery.

THE E. G. BERNARD COMPANY, Troy, N. Y., has recently completed a contract for wiring the State capitol. The installation was for about 7,000 lights, and was unique in many respects. All the wire was special size in both copper and lead covering, and dies had to be made to order. All of the cabinets, switches and cut-out centers were also from new and special designs. In one place in the construction there were sixty vertical holes drilled through Hallowell granite. These holes averaged from 19 to 17 feet long, and were met by horizontal holes from 4 to 8 feet long. These features show the difficulty in the construction and the thoroughness with which the work was accomplished. The E. G. Bernard Company has been highly complimented by the Superintendent of Public Works for the substantial way in which it carried out the contract.

VITAE BRUSHES, manufactured by the Le Valley Vitae Carbon Brush Company, 39-41 Cortlandt Street New York, are reported to be giving excellent satisfaction, especially to street railway companies for car motors. It is stated that many of the largest roads in the country are using.

these brushes. The company has on exhibition at its office brushes which are said to have run over 5700 miles on a car motor. The brushes were only worn down a quarter of an inch, and could have run on that same basis of wear many thousand miles more. The company states that the commutators on which these brushes were placed were not worn or scratched a particle during the entire length of run, and that in many cases their brushes have run from 8000 to 10,000 miles on car motors.

THE STOREY MOTOR AND TOOL COMPANY has moved its main office and factory from Philadelphia to 464 South Broad Street, Trenton, N. J., in a plant with the Trenton Iron Company. The company is well and favorably known on account of its entirely inclosed dust and moisture proof motors, the first of that style to be placed on the market. The increased demands which they receive for this apparatus have necessitated the removal. The motors are now issued to the trade in a much higher state of mechanical and electrical improvement than ever before. With increased facilities, the Storey Company will push on the market its open type machines for all classes of standard work, together with several other specialties which up to the present time they have been unable to present to the public.

MR. MAX LOWENTHAL has been recently added to the editorial staff of the "Electrical Engineer," and will hereafter hold the position of associate editor on that well-known weekly. Mr. Lowenthal is eminently fitted for the duties he will be called upon to perform, as he has studied extensively abroad and graduated at the head of his class at the Hebrew Technical Institute. He also holds the degree of E. E. from Columbia University. Mr. Lowenthal was for some time in the testing rooms of the Western Electric Company, and later had charge of the testing department of the Schuyler Electric Company at Middleton, Conn. He has been a frequent contributor to the electrical journals, is a member of the New York Electrical Society and associate member of the American Institute of Electrical Engineers. The "Electrical Engineer" is to be congratulated upon securing his services.

THE CLOOS ENGINEERING COMPANY, Milwaukee, Wis., has lately been organized and thoroughly equipped for doing a general electrical contracting business, and will make a specialty of complete electric light and power plants. This company controls exclusively the Cloos patents on high potential dynamo and feeder switches, single and double coupling boxes, alternating and direct junction boxes, etc. The company is exclusive selling agents in the Northwest for the apparatus manufactured by the Northern Electrical Manufacturing Company, consisting of both belted and direct-connected dynamos and motors of all sizes, and is prepared to make prompt delivery of switchboards, dynamos, motors, arc and incandescent lamps, etc. The officers of the company are Herman W. Falk, president; Jacob Cloos, vice-president and general manager; E. A. Wurster, secretary; C. R. Falk, assistant secretary; H. R. King, treasurer.

THE SOLAR CARBON & MANUFACTURING COMPANY, Pittsburg, Pa., has an interesting plant located at Mahoney, 62 miles up the Allegheny River from Pittsburg. This location was chosen because of its proximity to the natural gas fields, from which cheap fuel can be obtained for baking carbons. As the fuel constitutes one of the chief expenses of the process, this is an important consideration. The company has built six buildings, which occupy a tract of 100 acres. It has a complete plant for the manufacture of its product, and, furthermore, considerable special machinery, with calcining and baking furnaces, which are also of special construction. The company furnishes as its product electric light carbons, both solid and cored; brushes for generators, motors, battery cylinders, smelting rods, for electric furnaces; telephone parts; tubes and granules for telephone transmitters. A recent product of the company, and one in which it enjoys a monopoly, are carbon pencils of a particularly fine grade, being very smooth and homogeneous in construction. The composition of these conductors involves no acid constituents and, in consequence, they last four or five times as long as some of the foreign made carbons. Indeed, they are even being exported for use in chemical and refining plants abroad.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has installed

I-T-E
CIRCUIT BREAKERS
CUTTER ELECTRICAL CO., PHILADELPHIA

Few electrical instruments have been received with the same favor throughout the entire world as has been accorded to the Circuit Breaker. The Cutter Electrical and Manufacturing Company, of Philadelphia, pioneers in this field, have, for some years past, devoted almost their entire attention to the important subject of protection to electric circuits and electrical apparatus. The Circuit Breakers are usually placed on the switchboard and, as their name implies, break the circuit automatically should the current reach a predetermined danger limit. The instruments are susceptible of a wide range of adjustment and are instantaneous in their action. They have frequently been called "electric safety valves," as they afford practically the same protection to an electric circuit that a safety valve does to an engine.

The Cutter Company have developed instruments suitable for either direct or alternating current, of any capacity required and for any voltage. The instruments are beautiful in themselves, being made from the most part of polished copper and iron and steel copper-plated, and are mounted on white marble or black enameled slate. Their accuracy in operation on the circuits for which they are intended is absolutely guaranteed, and the many large switchboards thoughout the United States, which are equipped entirely with this form of protection, give evidence of the favor with which these instruments have been received by leading engineers and electricians. A catalogue will be sent upon request.

BUNDY STEAM TRAP.
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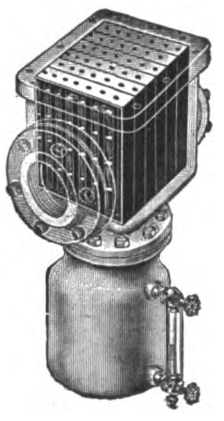

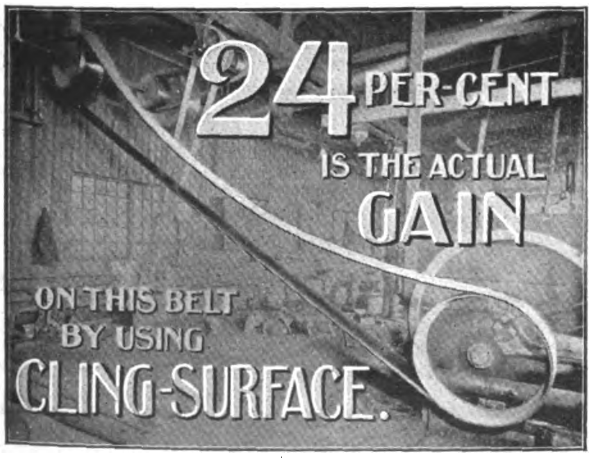

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a large amount of apparatus for the production of refined copper by electrolytic processes. One of the principal installations is at the refinery of the Anaconda Copper Company, Anaconda, Mont., where ten generators of 270 to 300 k.w. capacity have been installed. Another installation is that of the Boston & Montana Consolidated Copper and Silver Mining Company, Great Falls, Mont., where two 810-k.w. Westinghouse engine type generators are in service. The latest comer in this field is the Raritan Copper Works, of Perth Amboy, N. J., which are about to erect the largest copper refinery in the East. They have contracted with the Westinghouse Electric and Manufacturing Company for three 600-k.w. 150-volt engine type generators, 150 r.p.m., with a nine section switchboard for electrolytic service and the operation of two 75-k.w., 200-volt, engine type generators, which will be used for lighting and power service. The installation will be the most complete of its kind in the world. The Westinghouse Company has also sold recently to the Manufacturers' Building Company, Providence, R. I., 2 250-k.w., 500-volt, engine, type generator, 100 r.p.m., to be driven by an Armington & Sims Corliss engine. This generator will supply power for the operation of motors in the various departments of the Manufacturers' Building, which has accommodations for upward of sixty manufacturing concerns, being particularly equipped with conveniences for the production of jewelry, specialties, etc.

THE STANDARD OF CORRESPONDENCE SCHOOLS has been most decidedly raised by the conscientious efforts of the Electrical Engineer Institute of Correspondence Instruction in its attempts to furnish the profession of electrical engineering absolutely reliable and trustworthy instruction. Much of the success may doubtless be attributed to the eminent authorities who have certain departments of instruction in charge, among which we may name Prof. Francis B. Crocker, of Columbia University; Charles F. Scott, the well-known alternating expert; Elmer G. Willyoung; William Maver, Jr., the celebrated authority on telegraphy, and Thorburn Reed, a dynamo designer of acknowledged merit. The instruction which the student will receive from the papers prepared by these gentlemen will partake of a practical nature, which it is difficult if not even impossible to duplicate in some of the technical schools, and it might assuredly pay many who are supposed to have gotten beyond the grade where instruction is necessary, to procure these papers for their own information. Many a man whose attainments stand unquestioned in the profession might easily find it advantageous to enroll as a student and obtain these advantages, thereby refreshing his mind on subjects long forgotten and bringing himself fully up to date in the latest developments and practical applications of his profession. In connection with the work of the Institute mention should be made of the interesting book of information entitled, "Can I Become an Electrical Engineer?" which is sent free upon request and contains a complete portrait collection of the most prominent scientists and engineers who have succeeded in making the profession of electrical negineering what it is to-day. This book will be sent free on application to the home office of the Institute, at 120 Liberty Street, New York.

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TOURS IN THE ROCKY MOUNTAINS.

The "Scenic Line of the World," the Denver & Rio Grande Railroad, offers to tourists in Colorado, Utah and New Mexico the choicest resorts, and to the trans-continental traveler the grandest scenery. Two separate and distinct routes through the Rocky Mountains, all through tickets available via either. The direct line to Cripple Creek, the greatest gold camp on earth. Double daily train service with through Pullman sleepers and tourists' cars between Denver and San Francisco.

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Write S. K. Hooper, G. P. & T. A., Denver, Colorado, for illustrated descriptive pamphlets.

New Wabash
Fast Train East.

"The Continental Limited," a new fast train on the Wabash, now leaves Chicago daily at 1:02 noon for Detroit, Niagara Falls, Buffalo, New York and Boston. This train arrives Buffalo next morning at 5 o'clock, New York at 3:30 and Boston at 5:50 P. M the next day—only one night on the road. The service, including a dining car, is first-class in all respects. Do not fail to ask for a ticket via the "Continental Limited" on your next trip East.

Other trains for the East via the Wabash leave at 8:50 A. M., 3:15 P. M., and 11:30 at night.

For maps, time tables, etc., write to F. A. Palmer, A. G. P. A, 97 Adams St., Chicago.

The Belknap Motor Co.

OF PORTLAND, ME.

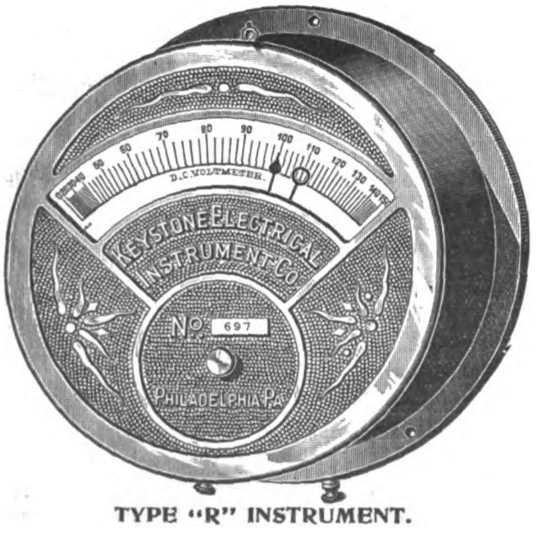
is very busy at the present time. They are just installing one 40 k.w. direct connected generator and engine in the new building of the Y. M. C. A., Portland, Me. They are also putting in a direct connected electric passenger elevator at the Falmouth Hotel, Portland, Me., in place of an hydraulic formerly in use. They have just completed an electric direct connected freight elevator for the Portland Packing Co., taking out an hydraulic. A hand elevator at E. D. Pettingell's Pickle Works, Portland, has just been taken out and a new direct connected electric has been put in its place by this company. They are also completing a new electric freight elevator for L. B. Griffin, produce dealer, Portland, Me., and have just received order for a direct connected electric elevator for the Hotel Jocelyn, Prout's Neck, Me.

Their direct connected elevator business has become very large; they have installed more elevators in Portland and vicinity in the last two years than all other companies combined. An electric conveyor for discharging vessels has just been installed by them for the Maine S. S. Co., and they have a contract from the same company for a second one. They had previously installed one for the International S. S. Co. at Eastport, Me.

The Chapman Voltage Regulator, manufactured by the Belknap Motor Company, is getting to be one of the most important parts of their business. The Mt. Morris Elec. Co. of N. Y. City, ordered two several months ago, and so well satisfied were they with the results accomplished by their use that they placed their order for seven more, all of which have been shipped to them.

The People's Elec. Co. of Orange, N. J., put in one several months ago, and liked it so well that they have placed their order for a second, which is about ready for shipment.

Frank Jones Elec. Lt. Co. of Portsmouth, N. H., has placed order with them for three of the No. 1 type, which are to be finely finished and erected on pink Tennessee marble, which will be in keeping with the balance of the plant.



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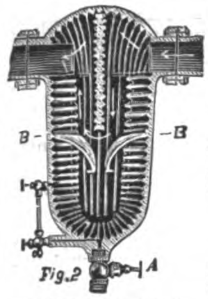

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The Hine Eliminator after several years' use on LIVE Steam line has proved so eminently satisfactory we desire another one 4 in. in size. *Lackawanna Mills.*

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The Electrical Power and Lighting Scholarship is a thorough course of instruction in the installation, care and operation of electric light, power and railway plants, designed to meet the wants of busy men who wish to put into practice as soon as possible the information they acquire

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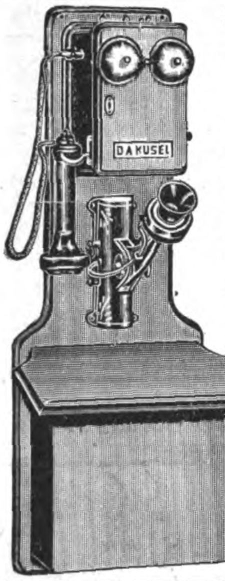
ELECTRICIAN, aged 27, with practical experience of over eight years in manufacturing, construction and light and power work, desires permanent position as manager of light and power or street railway company. Address "G. W.," care of AMERICAN ELECTRICIAN, Havemeyer Building, New York, N. Y.

SALESMAN, competent and experienced, desires position in the West as salesman in store, city soliciting or traveling for general supplies or specialty. References: Pierce & Richardson, E. E., Chas. F. Foster, E. & M. E., both Manhattan Bldg., Chicago, Ill., and F. Bissell & Co., jobbers, Toledo, O. Address W. S. RYERSON, care of F. Bissell & Co., Toledo, O.

FOR SALE.

FOR SALE.—X-Ray Induction Coil, oil insulation, four to six inch spark. Price $35.00, including box with lock and key. Also a few "Greeley" Testing Set Astatic Galvanometers—new—$5.00 each. R. PFUND, Room 70, 195 Broadway, New York City.

LOCOMOTIVE DUMMY FOR SALE. Built by the Baldwin Locomotive Works; in good condition; 4 feet 8½ inches gauge; weight on driving wheels 24,000 pounds; cylinders, 9x12; driving wheels, 30 inches outside diameter. Will be sold cheap. Dummy can be seen and specifications of same can be obtained from PASSAIC LIGHTING COMPANY, Passaic, N. J.



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WILLIAM CLEMENT LEONARD,
GENERAL FINANCIAL AGENT,

Mention this Paper when writing. CHARLESTON, W. VA.

NOTICE.

Pursuant to resolution of the Mayor and Common Council of the city of Superior, passed and adopted July 19th, 1898, I, the undersigned, the City Clerk of said city, hereby solicit and advertise for bids for lighting the streets and public places of the city of Superior, as follows:

1st. For furnishing 50, 100, 150, 200 electric arc lights of 1200 or 2000 nominal candle power for the terms of 1, 2 and 3 years. Such lights to be disposed and placed about the various portions of the city as directed by the Common Council; stating the time when such lights can be furnished.

2d. For furnishing 50, 100, 150 and 200 Welsbach naphtha gas or gasoline lamps of from 80 to 100 candle power each for the terms of 1, 2 and 3 years, to be disposed and placed about the city as directed by the Common Council.

3d. For furnishing 200, 300, 400, 500, 600, 700, 800 and 1,000 common 16 candle-power naphtha, gasoline, or gas lamps for the terms of 1, 2 and 3 years, to be disposed and placed about the city as directed by the Common Council.

4th. For furnishing any combination of the above lights.

5th. For furnishing any other style or manner of light suitable for the streets and public places of the city of Superior for the terms of 1, 2 and 3 years.

All such propositions to be for lights burning all night, from dark until daylight; plat of the city furnished by the City Engineer on request; bids to be accompanied by certified check of $500 as evidence of good faith, drawn to the City Treasurer; and the city reserving the right to reject any and all bids; all bids to be in by the 16th day of August, 1898; all bids to be sealed and addressed to the undersigned.

Dated this 23d day of July, A. D. 1898.

F. J. SEGUIN,
City Clerk.

YOU WILL CONFER A FAVOR

both upon the advertiser and the publisher if you will mention the **American Electrician** when writing to companies whose announcements appear in this paper.

American Electrician.

Vol. X. New York, September, 1898. No. 9.

THE DEVELOPMENT OF THE HYDRAULIC POWER OF THE HUDSON RIVER AT MECHANICVILLE.

The development of the power of St. Anthony's Falls on the Mississippi at Minneapolis, Minn., is followed closely by the utilization of the power of the upper waters of the Hudson River at Mechanicville, N. Y., where an undertaking of no less magnitude has, within the past few days, been completed. Five to seven thousand h.p. is available at the power house and the use of high tension current permits of its distribution over a wide territory.

As in the Mississippi, the waters of the Hudson above the present point of development have been, to some extent, employed by factories using low head turbines directly driving their machinery, but not until the undertaking just concluded was decided upon had any very serious effort been made to take advantage of the great amount of power which has run to waste for ages down the stream of the main waterway of the Empire State.

Early in 1897 the attention of Mr. R. N. King, President of the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, was drawn to this water power. His long experience with water powers and their development, led him speedily to recognize the possibilities which were presented. The site is but two miles from Mechanicville, eleven miles from Troy and eighteen miles from Albany, in each of which towns large quantities of power would doubtless find a market. But, most important of all, it lies only seventeen miles from Schenectady, where, covering not less than 130 acres of ground, the largest electrical works in the world are operated from an extensive steam plant, with which the electrical power from the Mechanicville cataract could readily compete.

After consultation with the chief engineers of the General Electric Company, in which the necessary assurances were given, Mr. King formed the Hudson River Power Transmission Company.

The hydraulic engineering features of the development were carried out in their entirety by Mr. A. C. Rice, Chief Engineer of the Stilwell-Bierce & Smith-Vaile Co., and it may be said that in the completed

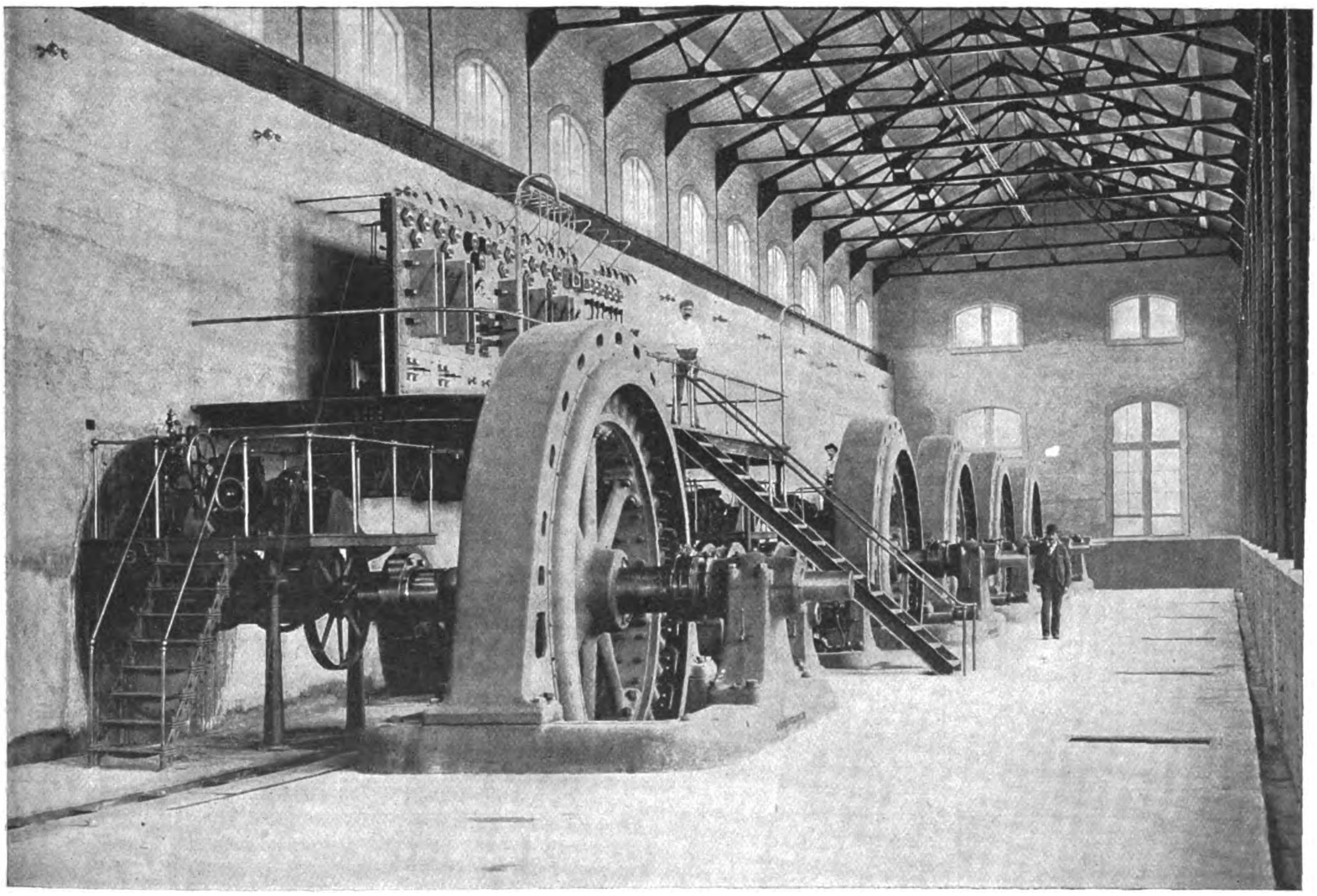


FIG. I.—GENERAL VIEW OF STATION INTERIOR.

work as it stands to-day little or no departure from the plans laid down by Mr. Rice has been made. As the General Electric Company was to purchase the largest amount of power, its advice as to the electrical equipment was naturally closely followed. The result brought about by the harmonious co-operation of both hydraulic and electrical engineers is a power transmission plant in every respect strictly representative of the most modern hydraulic and electrical practice.

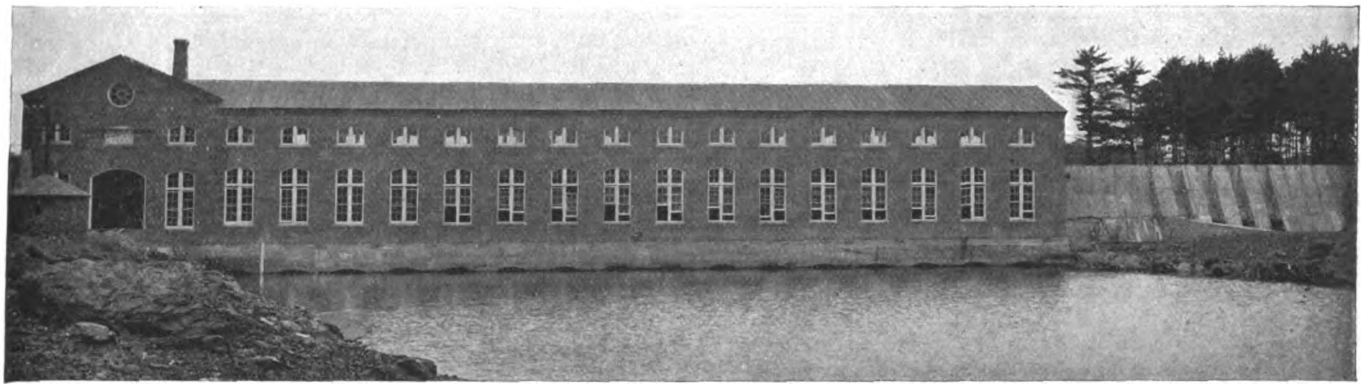


FIG. 2.—GENERAL VIEW OF POWER HOUSE.

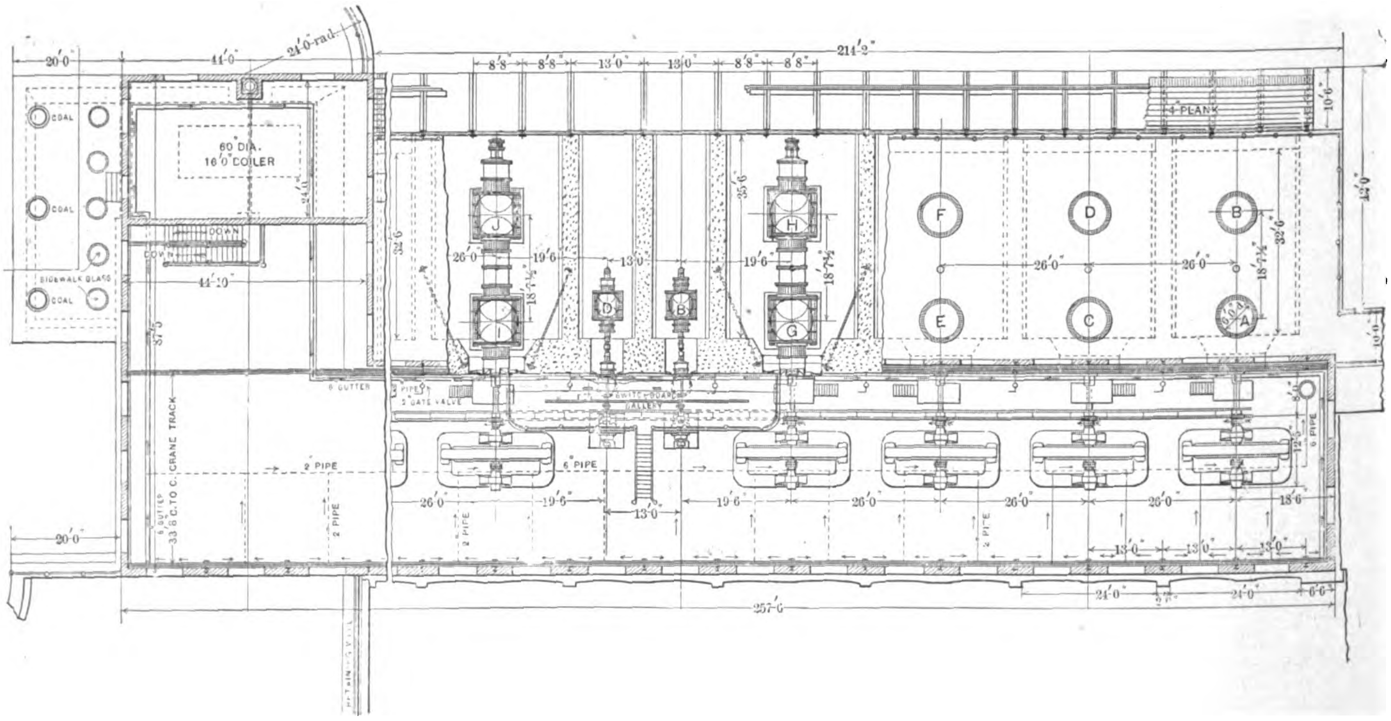


FIG. 3.—PLAN OF POWER HOUSE.

At the point chosen for the hydraulic development the physical conditions make the location an ideal place for a dam and power house. The banks and bottom of the river are of rock, as is Bluff Island, immediately adjacent, which divides the Hudson into two channels. During the greater part of the year there is water sufficient to produce from 7000 to 10,000 h.p.

The island is about one-third of the distance across the river from the western bank, the combined width of the two channels being about 1200 ft. The western channel is used for the head and tail races.

In order to make the excavations for the power house and the main dams, heavy cofferdams were built across both streams. The work would have been completed well within the time at first specified had not an extraordinary freshet swept away part of the cofferdam, necessitating long delay. The rock and shale resulting from the excavations proved unsuitable for incorporation into concrete, and the broken rock used was brought over a special track from the neighborhood of Schenectady.

The power house extends from the western bank about 215 ft. into the river and is connected with Bluff Island by a concrete dam, 26 ft. high above the bed of the river, 10 ft. wide on top and 18 ft. wide at the base. The upstream face is vertical and the downstream face is sloping. The top of this dam is at an elevation that the water will never reach; thus no provision is made to take care of falling water on the down stream side, but the dam is provided with four arch waste gates, 4 ft. wide and 6 ft. 9 ins. high, operated in the same manner as those in the main dam.

The main dam is on the eastern side of the island. It is built entirely of concrete, as, indeed, is the entire construction with the exception of the upper walls of the power house. The upstream face is vertical, the downstream face is curved and provided with a horizontal apron 14 ft. wide, which throws the falling water off horizontally, and thus effectually prevents wash or scour of the toe of the dam. The dam is 16 ft. high above the river bed, 8 ft. thick immediately below the crest, 16 ft. thick through the base and 30 ft. thick through base and apron. The dam is set between massive abutments anchored to the rock sides of the river bank and island. The eastern is 20 ft. long, 26 ft. high above river bottom, 16 ft. thick at the top and 34 ft. wide at the base. The western abutment is 100 ft. long, the other dimensions being similar to those of the eastern abutment. The length of the spillway between abutments is 800 ft. In the western abutment are twelve arched waste gates of ample proportions. Each waste gate is 4 ft. wide and 6 ft. high, and is opened and closed by a heavy iron hoist operated by rack and pinion. The eastern dam is practically a solid rock wall capable of

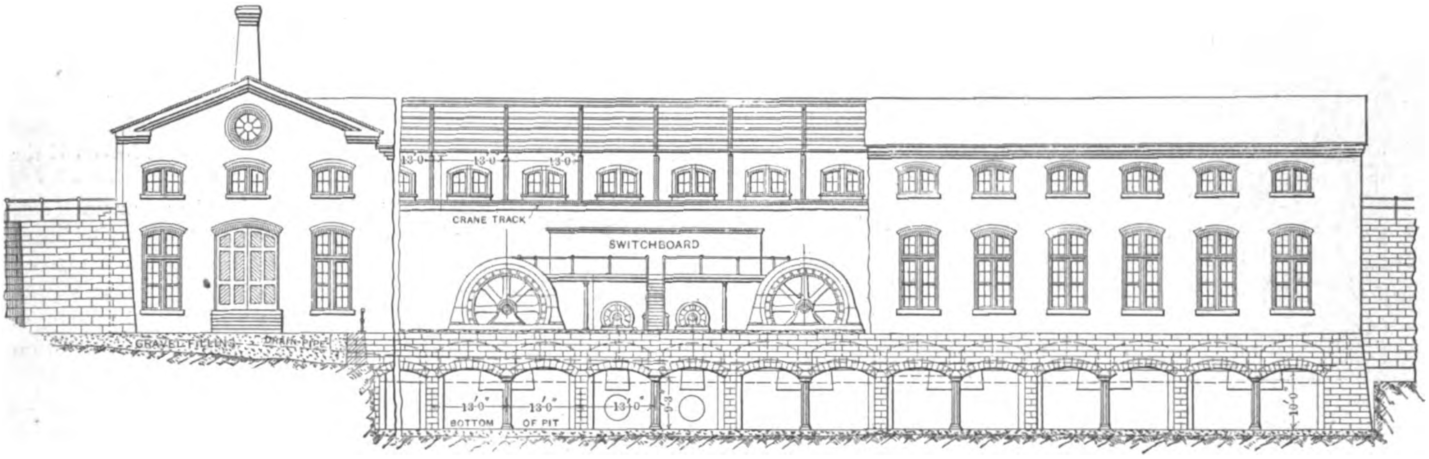


FIG. 4.—SIDE ELEVATION, LOOKING UP STREAM.

safely resisting any flood. It was severely tested in the spring of 1898, when a flood of extraordinary proportions came against it, yet, notwithstanding the fact that the dam was green, the flood in no manner injured it. To prevent any floating rubbish, ice, or logs reaching the rocks or choking the waste gates, a floating wooden boom stretches from the western end of the spillway diagonally for a distance of 400 ft. to the edge of the normal river bank, and then for a distance of 1000 ft. to the main embankment of the Mechanicville highway. It is anchored to a line of stone-filled cribs.

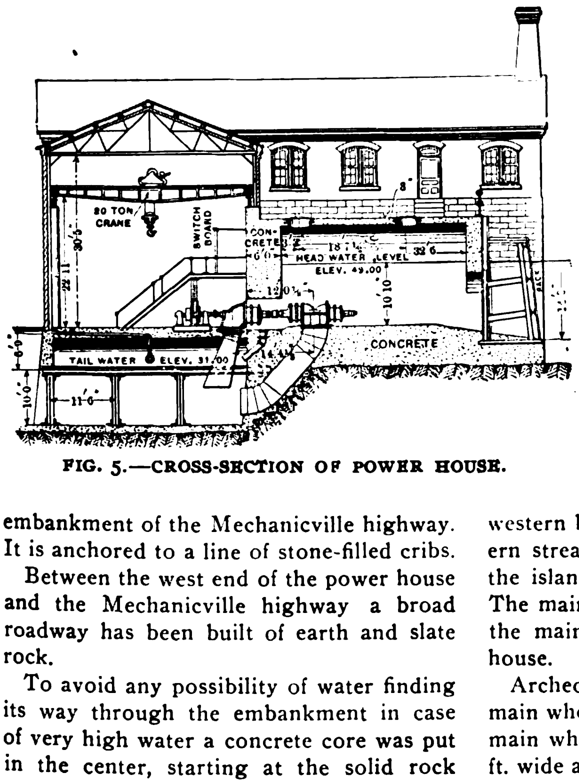


FIG. 5.—CROSS-SECTION OF POWER HOUSE.

Between the west end of the power house and the Mechanicville highway a broad roadway has been built of earth and slate rock.

To avoid any possibility of water finding its way through the embankment in case of very high water a concrete core was put in the center, starting at the solid rock and finishing 2 ft. below the surface of the road. The embankment forming the roadway is 40 ft. wide on the top, 124 ft. at the base and 18 ft. high at the deepest point.

The power house lies between the west bank and the short concrete dam, nearly filling the space between the island and the west bank of the river. It is practically a continuation of the dam, and, like the main dam, is of concrete with the exception of the upper walls. Its construction is of the most substantial character, the foundations are carried down to bedrock, and the house is carried on heavy steel box-web girders resting upon steel I-beam columns. The latter are imbedded in concrete walls carrying arches which form the floor of the generator room and the floor on which the wheel flumes rest. The walls form a separate and distinct tail race 22 ft. wide for each set of turbines, from which the water may be shut out at will.

The house is divided into two parts by a thick head wall. The upstream part contains wheel chambers for seven 1000 h.p. wheels, of which five only are at present occupied. The downstream portion contains the wheel governors and the electrical apparatus. The length of the power house proper is 257 ft. 6 in.; the width of the dynamo room between head wall and south wall 34 ft., and the width of the wheel chamber portion 32 ft. 6 in. The total width of the power house is 66 ft. 6 in. At the western end an L extension runs up stream 87 ft. 5 in. long and 44 ft. 10 in. wide. This portion of the power house is of brick. A retaining wall runs down stream from the power house along the western bank a distance of 50 ft. The western stream running between the bank and the island forms the forebay, 300 ft. long. The main tail race is 205 ft. wide and joins the main stream 750 ft. below the power house.

Arched chambers are provided for seven main wheels and two exciter wheels. Each main wheel chamber is 32 ft. 6 in. long, 22 ft. wide and 17 ft. 5 in. high and is provided with two 6-ft. manholes. Each exciter wheel chamber is 32 ft. 6 in. long, 17 ft. 5 in. high and 10 ft. wide. The head wall of the chambers is 6 ft. thick, the wall on the upstream and both sides 3 ft. thick. In the head wall of each main chamber is set a heavy cast iron cover through which the the turbine shaft passes in a watertight packing box, carrying the ring oil bearing for the shaft. The saving in space effected by the new arrangement of housing and coupling together of the turbines, patented by the Stilwell-Bierce & Smith-Vaile Co. has tended to diminish considerably the size of the power house.

A 20-ton crane from the works of Pawling & Harnishfeger, Milwaukee, runs the entire length of the dynamo room.

In front of the wheel chambers and running the entire length of the power house is a trash rack of steel bars supported on a framework of steel channel and I-beams. This rack effectually prevents the access to the wheels of any rubbish or floating material that may escape the boom.

The main wheel plant consists of ten pair of 42 in. horizontal Victor turbines of the latest type, built by the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio. Each main turbine consists of two pair of wheels which, at the normal speed of 114 revolutions is rated at 250 h. p. The wheel power of each set of turbines is therefore 1000 h. p. Five units are now in position; the two additional turbines will be installed shortly. The head under which the water wheels are operated is 18 ft.

The turbines for the exciters consist of three 18-in. Victor cylinder gate wheels, having, at 259 revolutions per minute, a total of 300 h.p. The quarter turns and packing boxes of these wheels are brought through the wall beneath the station switchboard.

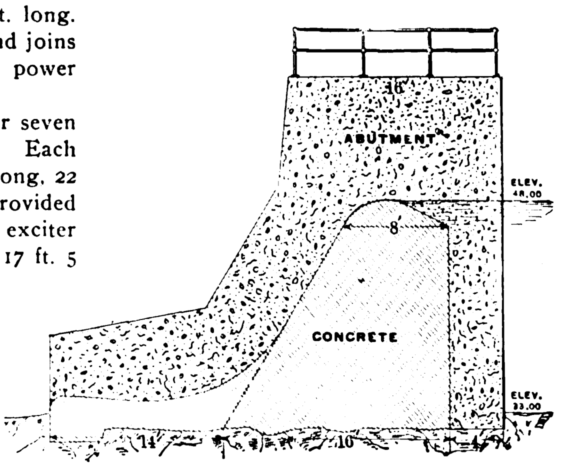


FIG. 6.—SECTION OF DAM.

Two draft tubes lead from each main turbine, the forward tube descending straight into the tail race beneath the power house, the rear or upstream tube curving and flaring downward and outward. Each tube is 9 ft. 6 in. in diameter at the bottom. Two draft tubes are also allotted to each set of exciter wheels, the setting following a similar arrangement. The rear tube is 4 ft. in diameter, the forward tube 3 ft.

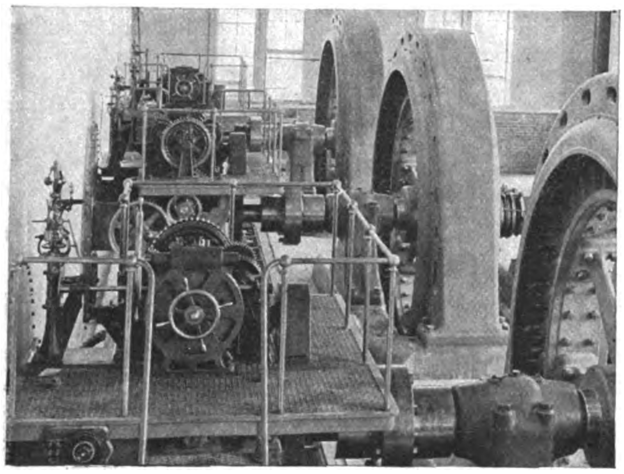


FIG. 7.=VIEW OF GENERATOR AND WATER WHEEL GOVERNOR.

The speed of each set of main wheels is regulated by a Geisler electro-mechanical governor, mounted on a platform directly over the turbine shaft, and between the head wall and the generator.

The use of electricity renders the mechanism of this governor extremely sensitive and effective, and the gates can be entirely opened or shut, should the full current be thrown on or off, in six seconds. The driving pulley is replaced by a rawhide pinion, giving a rigid connection between the governor and the wheel, and making 400 r.p.m. The speed may be increased to shut off or throw on in less than six seconds, if necessary. The Geisler governor is now in use in many of the most important electric power transmissions in this country, including those of Columbia, S. C.; Pelzer, N. C.; Lachine, Que.; West Kootenay, B. C.; Montmorency, Que.

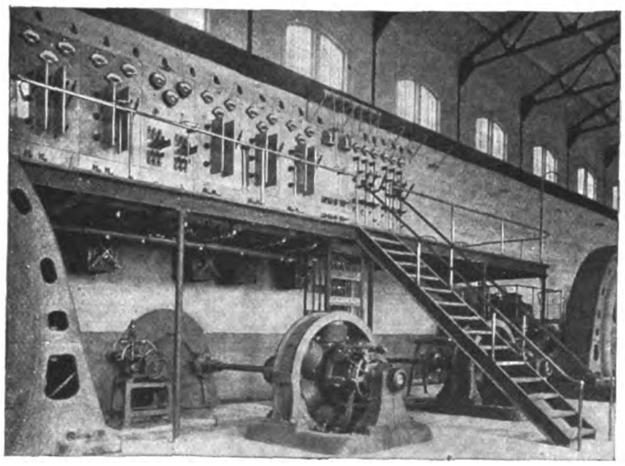


FIG. 8.—EXCITERS AND SWITCHBOARD.

The governors controlling the exciter wheel gates are improved "Snow" governors, which rapidly bring the speed to normal when changes are neither frequent nor heavy. They are especially adapted to the regulation of water wheels driving exciters and are provided with adjustable stops which limit the hoisting action on the gate as soon as the gate is fully open.

The dynamo room is a spacious chamber well lighted by windows on all sides. It is 255 ft. long and 34 ft. wide, 30 ft. 5 in. in the clear from floor to roof truss and 22 ft. from floor to crane. The ultimate generator capacity of the station is 7000 h.p. in seven generators each of 750 k.w. capacity. Five have been installed and are now running. They are unitooth, three phase, fortypole 750-k.w. 114-revolution, alternating current machines, having revolving fields and stationary armatures, and wound to deliver 36 amperes of current at a periodicity of 38 cycles and a pressure of 12,000 volts to the transmission lines. They are arranged for operation in parallel at constant voltage. By using the revolving-field type of generator and thus securing this pressure directly from the machine the use of step-up transformers to raise the voltage for transmission purposes is avoided. As the current is to operate synchronous and induction motors, to operate lights and to be converted into direct current through rotary converters, the frequency of 38 cycles was selected as most suitable for the different conditions required.

The alternators are similar in their main characteristics to those successfully used in the development of the power of the Lachine Rapids at Montreal. The armature frame or ring is of the box type, 15 ft. 4 in. in diameter and 36 in. wide. It is bolted to a base 18 ft. 2 in. long by 10 ft. wide, along which it may be moved parallel with the shaft, in order that the revolving field spider and poles may be uncovered should occasion require. The armature winding is protected on each side by iron shields. The pillow blocks are also bolted to the base and the bearings are of the spherical seated self-oiling type used in all General Electric generators.

The field ring is bolted to the spokes of the spider. It carries forty poles, each securely fastened by two bolts to the ring. The whole revolves on a shaft 15 in. in diameter provided with a rigid coupling on the turbine shaft. The dynamo shaft is extended for coupling to a vertical steam engine in case of necessity.

The following reasons for selecting this type of alternator have been given by Mr. C. P. Steinmetz, of the General Electric Company:

In addition to the advantage which the stationary armature type has over the stationary field type in allowing a high transmission voltage to be taken directly from the armatures, it allows of a fairly low saturation of the magnetic circuit, giving an almost straight saturation curve. This is preferable in power transmission, since a considerable increase in the voltage may be obtained if needed to cover excessive drop in the lines, due to heavy loads, etc., and the voltage may be maintained even if the speed remains low.

The exciters are placed one on each side of the stairway leading to the switchboard gallery. They are 6-pole 100-k.w. 125-volt standard General Electric machines with ribbed field frame and iron-clad armatures.

The switchboard, erected on a gallery on the north wall of the dynamo room, is built up of nine highly polished panels of blue Vermont marble, each panel 7 ft. 6 ins. high, 3 ft. wide, and 2 ins. thick. Of these nine panels five are used for the generators and two for the feeders; one is the total output panel and the last is for the control of the exciters. The generator panels occupy the left side of the board, and room on the gallery is left for two additional panels. The feeder panels are on the right hand side; the total output panel is between these and the generator panels and the exciter panel is the third panel from the left-hand end of the board.

Each generator panel is equipped with the following instruments: One inclined coil alternating ammeter reading to 75 amperes for the generator, and one direct current ammeter reading to 150 amperes for the field. Above each of these is a pilot lamp, and between each pilot lamp is a synchronizing lamp. Beneath the two ammeters is an inclined-coil voltmeter reading to 15,000 volts, and beneath this instrument are three single-blade double-throw, quick-break, high-tension switches, which, seen from the front of the board, are each mounted upon pyramids of corrugated hard rubber. Similar pyramids in-

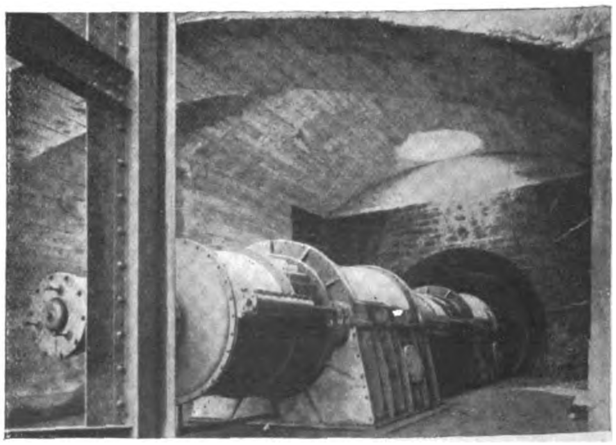


FIG. 9.--TURBINE CHAMBER.

tervene at the back of the board between the bus bars and the board. The corrugations give a total distance of about 8 ins. of surface between the metal clips and hinge, and the surface of the marble on each side. As these switches are to break a current of 12,000 volts, they are tested to break without difficulty currents of 21,000 volts. The switches are without handles. An eye is made in the end of each blade, into which a hook at the end of a stick may be inserted and the switch opened by the attendant from a safe distance. Further, to prevent any dangerous arcing from blade to blade, marble barriers 1¼ ins. thick, 3 ins. long and 12 ins. wide from the face of the board are erected between each blade.

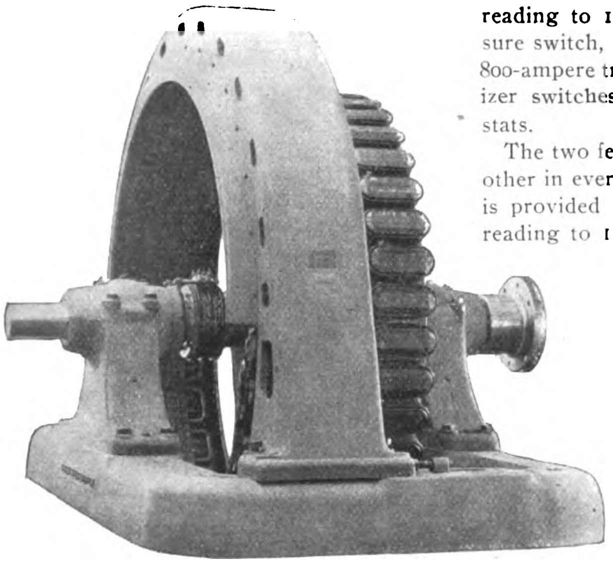


FIG. 10.—TYPE OF ALTERNATOR USED.

On the left-hand side of each generator panel sub-base are two 100-ampere double-pole double-throw carbon-break switches—one the field switch, the other the lighting switch. On the back of the panels are the high-tension fuse blocks.

These fuse blocks, designed for 20,000 volts, are of the snap-break expulsion type. They are mounted on pyramids of corrugated hard rubber, which carry copper spring contact clips between which two copper blades enter, connecting the fuse block to the line. The aluminum fuse is held tightly between two arms, which are movable around a pivot, and may be pulled apart by two strong spiral springs encircling this pivot. As soon as an increase of current in the line melts the fuse, its two halves are instantly pulled apart and thus the formation of an arc between the two halves is prevented. The melting of the fuse can only occur in a small chamber protected by wooden blocks. The whole device is covered by two vertical wooden boards. Sliding in between these wooden boards in vertical slots are fibre shields intended to prevent arcing over between the two arms after the separation of the two halves of the melted fuse. The two wooden blocks and fibre shields are held in position by four screws. The whole fuse block is inserted in the line simply by pushing the two blade-like copper contacts between the clip contacts, which are connected by solid copper rods to the bus bars. The wooden boards protecting the fuse are 10½ ins. long and 6⅜ ins. wide. The corrugated rubber pyramids on which the contacts are mounted are 3½ ins. high. The field rheostats are hung beneath the gallery, and are operated by hand wheels on the gallery and bevel gears below it.

The exciter panel controlling the two direct current exciters carries two pilot lamps, two circular dial ammeters, each reading to 1000 amperes, one voltmeter reading to 150 volts, one four-point pressure switch, one synchronizing switch, two 800-ampere triple-blade double-throw equalizer switches and two packed card rheostats.

The two feeder panels are similar to each other in every respect. Each outgoing line is provided with an independent ammeter reading to 150 amperes and a quick-break double-throw high-tension switch similar to those on the generator panels, and similiarly mounted on the board. Mounted also on corrugated hard rubber pyramids are the six circuit breakers or automatic plunger switches.

The high potential plunger switches consist simply of long copper rods sliding in hard rubber tubes. The upper ends of the rods reach into small rings, in contact with which they are held by a lever catching a small rubber head on the lower end of the copper rod. This lever is held in place by a spring, and is released by moving a rocker arm on the back of the switchboard. The moment it is released, a spiral spring pushes the copper rod downward, and by this movement, aided by the action of gravity, so suddenly is the contact broken that arcing between the rod and the ring is prevented. The rocker arm controls the three switches for each set of bus bars, so that they may all be released at once.

On the upper part of each feeder panel at the back is a current transformer for each outgoing line, two recording single-phase wattmeters, each reading to 25 amperes and 12,000 volts, and two potential transformers.

On the front of the out-put panel are two Thompson recording wattmeters for balanced three-phase circuits, each reading to 300 amperes and 12,000 volts, and twelve triple-pole single-throw 100-ampere switches with fuses for the lighting circuits. On the back are four potential and two current transformers.

The lightning arresters are of the G. E. short gap type. Arresters of this type have been installed on nearly all of the most important long-distance transmission lines in this country, and have proved a most satisfactory protection against damage by lightning.

The principle on which this arrester operates is very simple. It allows the passage of any high potential discharge, but effectually prevents the alternating current from following and maintaining an arc. The gap spaces in the lightning arresters at Mechanicville are very small—about 1-32 ins., each space lying between two solid metal cylinders 2 ins. in diameter and 2 ins. long. A low non-inductive graphite resistance is placed on the circuit, and the action of the arrester therefore is dependent upon the cooling effect of the large metal cylinders, aided by the reversal of the alternating current and the introduction of the non-inductive resistance. The line is protected by double-pole 2000-volt arresters, connected six in series to give the necessary number of spark gaps. There are three sets of these, one at Mechanicville, grouped around the first transmission pole in a small house 15 ft. square, one set on the Schenectady side of the Glenville bridge, where the overhead pole line connects with the underground cable, and the third at the works.

The lead covered leads from the generators are taken out at the base of the machine, and are laid in ducts in the floor. Rubber covered wire is used for the field connections. The cables rise on a frame from the duct to the floor of the gallery, through which they rise to the board. From the back of the board the line wires rise to supports bolted to the I-beam on the north wall, which supports one of the crane runways. The lines run along the north and west walls and pass out to the poles through a blind window over the door of the power house.

The line from Mechanicville to Schenectady is the only one at present laid down. It consists of three No. 000 B. & S. bare wires, this large gauge being employed in order to give the line as high a self-induction as possible. This insertion of self-induction in transmission lines is a departure from earlier practice. In cases where synchronizing apparatus is used self-induction is now considered necessary, and is artificially brought into the line in the shape of reactive coils in cases in which the natural self-induction is too small. The circuits are carried on poles of 30 to 60 ft. long and all 8 ins. in diameter at the top. Each pole carries one cross arm, on one side of which are two porcelain insulators of the petticoated type, a third being on the other side. For light-

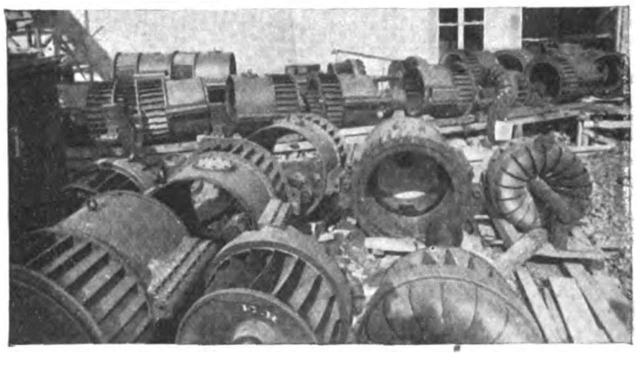


FIG. 11.—TURBINES BEFORE INSTALLATION.

ning protection a barbed wire frequently grounded runs along the top of the pole line.

The line takes a westerly direction to East Glenville and then due south to Schenectady. At the end of the Glenville bridge over the Mohawk—the town limits—it is carried down to the ground and connected to three cables of No. 1 gauge stranded copper, insulated by ¼ in. rubber and 3-32 in. sheet lead laid in terra cotta conduits. These cables run 1700 ft. along Washington Avenue, rise to poles again through Rotterdam Street to the Erie Canal, and along the canal to a point directly opposite the General Electric power station. They here cross the canal and enter the General Electric Company's works.

The introduction of this transmitted electrical power into the factory will work a considerable change. At present all the machinery is driven by electric motors, while the testing department demands an independent supply of current for the work it carries on. There are at present, therefore, two distinct generating plants. The 550-volt motors in the testing department are supplied from an engine driven multipolar generator of 500-k.w. capacity, while a smaller engine drives a number of exciters which allow of independent control of the excitation of all machines in this department. The factory is operated by a number of 250-volt motors, running on the same circuit as the factory lights. These motors will not be changed, and the steam plant which supplies them will be retained as a reserve in case the power from Mechanicville should fail. The electric power plant superseding the present steam plant at the works will, therefore, consist of two synchronous motors, one of 500 k.w., the other of 100 k.w., and three 400 k.w. rotary converters—the synchronous motors for the testing department, the converters to supply current to the factory motors.

The large engine driving the 500 k.w. multipolar generator is superseded by the 500-k.w. synchronous motors. This is a twelve-pole 400-revolution machine of the revolving field type, wound directly for 10.000 volts. The small engine driving the exciters is replaced by the 100-k.w. synchronous motor and eight-pole, 600-r.p.m. revolving-field machine similarly wound. This disposition renders this department independent of everything but the speed of the Mechanicville generators, which will be kept as nearly as possible constant.

The three rotaries supplying 250-volt current to the factory motors are ten-pole 400-k.w. 480-r.p.m. machines, having two commutators and two sets of collectors rings connecting to independent windings on the armatures. They receive the three-phase current from independent secondary coils of the same set of air blast transformers. When connected in multiple they furnish current at normal pressure of 250 volts, but as they may be called upon to furnish current to the testing department in case the demand exceeds the supply from the synchronous motor driven machine, they may be connected in series to give 500-volt current, operating in parallel with the 500-volt generator driven by the synchronous motor in the testing department.

The rotaries are operated in parallel and as well as all the factory lighting are operated from the same direct-current circuit, the latter on the Edison three-wire system, the neutral wire of the three-wire system being secured by connecting the transformers for the rotaries in Y with their secondaries and bringing to the neutral a lead from their common connection.

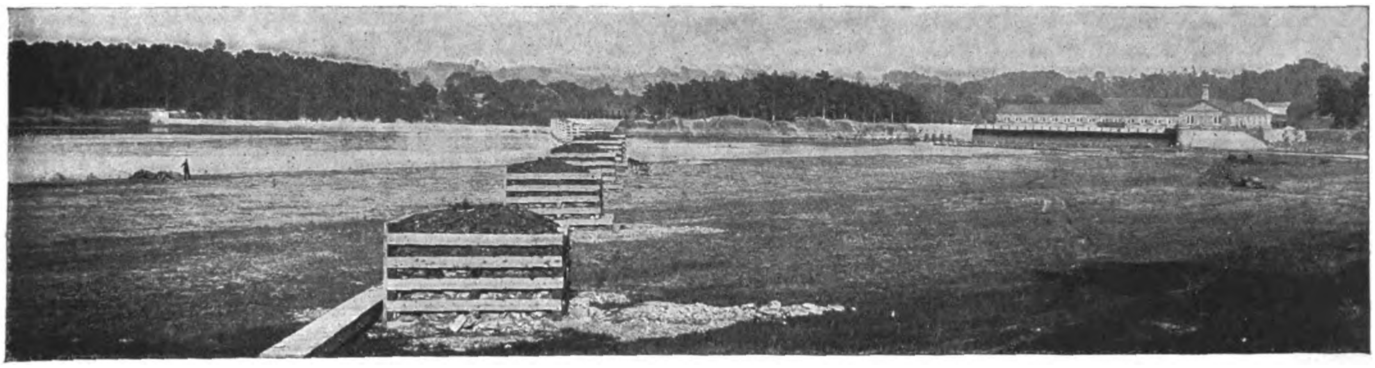


FIG. 12.—VIEW OF POWER HOUSE, SHOWING BOOM AND CRIB TO ARREST FLOATING REFUSE.

Synchronous motors were selected in preference to induction motors on account, first, of their more constant speed and greater efficiency; second, because they do not produce lagging currents, but the phase displacement and power factor may be controlled as desired by means of control of the field excitation.

Synchronous motors of the revolving field type and of good design are self-starting even under heavy load, and will easily carry two or three times full load without falling out of step for a time limited only by the heating of the motor.

To make the entire works system self-regulating in the direct current distribution and as far as possible independent of hand regulation, the rotary converters are given shunt field and powerful series field, so joined together that the machines operate as one unit. With constant voltage in the generating station at no load, the counter e.m.f. of the rotaries as given by their shunt field is below the impressed e.m.f. and a lagging current is produced. The self-induction of the lines is thus in opposition to the voltage, which is so reduced as to give 250 volts at the commutator brushes of the rotaries. As the load increases the counter e.m.f. of the rotaries rises, due to the series field, until at full and overload it is greater than the impressed e.m.f., and the current becomes leading. The e.m.f. of self-induction of the lines is then brought partly in phase with the voltage, which is increased so that in spite of the increased line current and consequently increased energy loss in the line, with constant generator voltage, the same voltage is produced at the commutator brushes of the rotaries at no load as at full and overload. This control is therefore automatic in every way, and did the synchronous motor not take current over the same line in varying quantities would suffice. To render this control perfectly automatic, therefore, small series transformers are inserted in the lines leading to the synchronous motor, feeding a small synchronous motor generator controlling the shunt field of the rotaries. By the combined action of their shunt and series fields, the voltage is automatically maintained constant at the commutator brushes of the rotaries and no hand regulation is required beyond that of readjustment in case the number of rotaries in operation is changed. The works of the General Electric Company were fortunately situated to make use of this natural power, and the results will certainly add to the argument that the choice of factory sites within transmission distances of large water powers is advisable.

The entire construction of the dams, power house and lines has been carried out with the highest engineering skill by the National Contracting Company, of which G. M. Furman is general manager, B. A. Mathews superintendent and J. A. Leonard constructing engineer. The electrical equipment is furnished by the General Electric Company, and the hydraulic equipment by the Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, to which company was confided the entire development contract. It took the Hudson River in its natural state and turned the complete plant over to the operating company.

The officers of the Hudson River Power Transmission Company are: General Edmund Fayes, of Buffalo, N. Y., president; R. N. King, president of Stilwell-Bierce & Smith-Vaile Company, of Dayton, Ohio, vice-president; G. M. Furman, Newark, N. J., treasurer; B. J. Richards, Boston, Mass., superintendent, and J. S. O'Shea, manager.

AMERICAN APPARATUS FOR THE METROPOLITAN ELECTRIC SUPPLY COMPANY OF LONDON.

Among the many contracts placed in America by British "consumers" during the last few years one of the most interesting and important is that recently given by the Metropolitan Electric Supply Company, of London, the largest municipal electric service company in Europe, to the Westinghouse Electric and Manufacturing Company and the Westinghouse Machine Company, of Pittsburg, Pa. The order calls for 7500 h.p. (in three units), of what are known abroad as "steam alternators." These units, though large for British practice, are but half the size of the Westinghouse generator units at Niagara Falls (5000 h.p.), but as they present a number of unique features of design and construction which have been developed by the Westinghouse Companies in their latest practice, a description of these alternators will be of special interest. The engines in particular are worthy of close study.

These three units are intended to supply primarily the arc and incandescent lighting service of London, but a portion of the power will be used for operating rotary transformers, which will, in secondary three-wire, direct-current distribution circuits, supply motors and storage batteries.

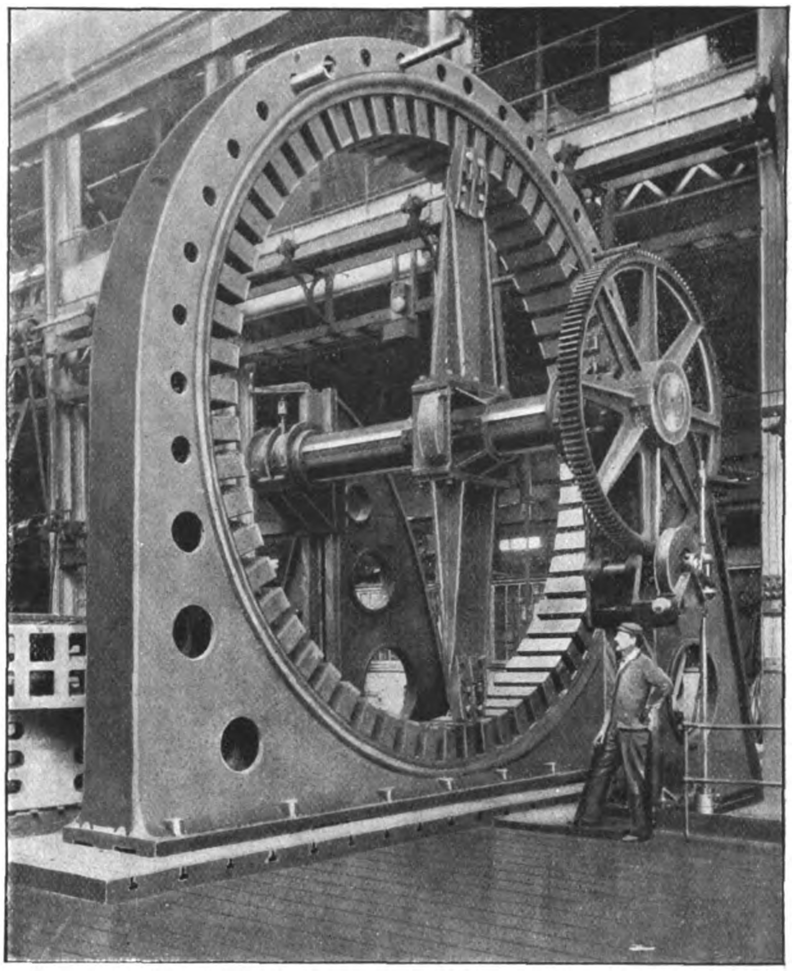


FIG. 1.—BORING LARGE ALTERNATOR FIELD.

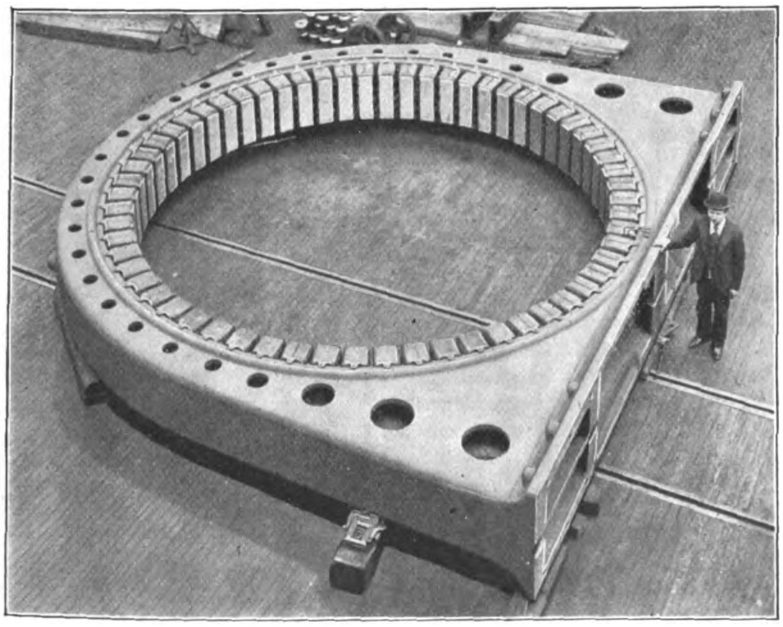


FIG. 2.—GENERAL VIEW OF COMPLETED FIELD FRAME.

The engines are the largest machines yet turned out at East Pittsburg, where the new shops of the Westinghouse Machine Company are located. The cut on the inset page shows a general view of the engine to excellent advantage, and by reference to the line drawing still further information can be had concerning this interesting prime mover. The engine when operating non-condensing is capable of developing the full rated power of the generator it is to drive, namely, 2500-h.p. at 133 r.p.m., the steam pressure being 100 lbs. If run at 120 r.p.m. with 140 lbs. steam pressure the engine can be loaded and will successfully carry 3500 h.p. All of the parts are strong enough to withstand a steam pressure of 200 lbs. to the square inch. The bed plates of these machines are of heavy box castings, intended to fit down over concrete foundations. The high and low pressure cylinders are 36 and 55 ins. in diameter respectively. The stroke is 36 ins. The cylinders are made of close grained cast iron, and, as the engine is of the vertical type, the danger of cutting the cylinder castings is practically negligible. The steam is distributed to the high pressure cylinder by a double ported piston valve, and two single ported piston valves perform the same office for the low pressure cylinder. The cylinders covers, pistons, etc., are provided with improved means to render their removal easy. Appropriate drains connected to the cylinders and steam chests and fitted with automatic water relief valves keep these important organs of the engines free from condensation. The drain valves are conveniently operated from the working platform by appropriate levers.

The crank shafts are of forged steel, 14 ins. in diameter at the bearings and 20 ins. at the armature hub. They are hollow throughout their entire length. The crank shaft extends, as will be noted in the pictures, so that the armature, which is the revolving element of the generator, may be mounted directly on the engine shaft and serve as a fly wheel.

The engines are fitted with permanent indicator rigs, which are accessible from the main platform, together with an elaborate system of lubrication, a system of cooling the bearings, and provision for varying the speed while running. All of these assist in enabling the engine to run for long periods without stopping. The main bearings of the engine are cooled by water, which is circulated about them. They are of the quarter-box type and can be moved in any direction by means of suitable wedges, which can be adjusted from without. The bearing shells are of cast steel or bronze, as the conditions may require, and are lined with the best babbitt metal. They are 14 ins. in diameter and 28 ins. long. Provision is made to allow the covers to be raised to facilitate inspection.

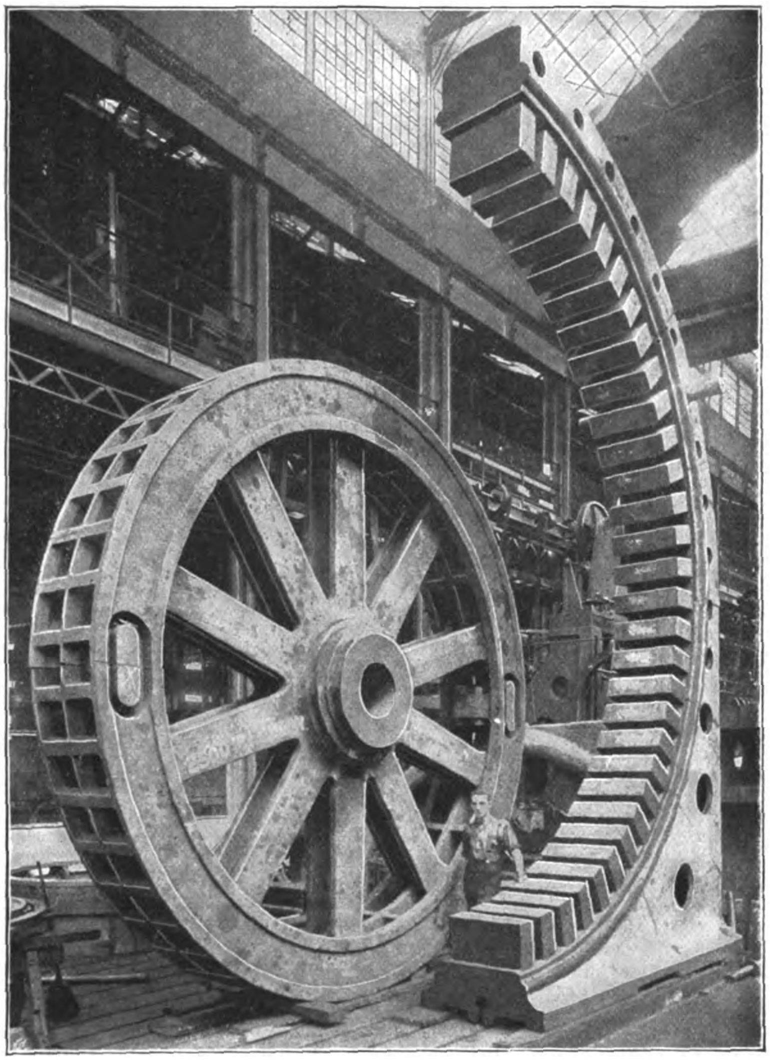


FIG. 3.—FIELD CASTING AND ARMATURE SPIDER.

The lubricators are sight feed. The oil is carried through brass tubes from the sight feed oilers and manifolds on the cylinders. These are connected to a reservoir on top of the cylinders, which is supplied by a force pump, which takes the oil from filters.

The engine is controlled by an open single weight inertia governor, which actuates the high pressure valve. The low pressure valves are operated by fixed eccentrics. The governor is keyed to the main shaft and is capable of 10 per cent adjustment while the engines are running. This is an important feature, for it enables the speeds of the machines to be varied to facilitate parallel operation. The maximum variation of governing at any speed within the rated limits is 1 per cent. The throttle is operated by a hand wheel, which is situated on the working platform.

The generators were built by the Westinghouse Electric & Manufacturing Company. They have a nominal output of 200 h.p. and are capable of delivering two-phase currents at a pressure of 500 volts. The field, or stationary element, is provided with 62 inwardly projecting pole pieces. These pole pieces are built up of laminated steel sheets and are cast into the frame. An excellent view of the field frame is shown in Fig. 1, in which it is in the process of being bored. This massive member, with its 62 pole pieces, cast, as they are, at accurately spaced intervals into such a heavy mass of metal, represents no mean specimen of the founder's art. The immense boring bar and the correspondingly large devices for centering the field frame about it are an illustration of the magnitude of the generators and the facilities which were necessary for performing and carrying out such a contract as this one. An interesting view of the completed field is shown in Fig. 2. In this picture, as will be noted, it is lying on its side and is complete with its field bobbins in place. The dividing line in this casting is vertical, and enables the two halves of the field frame to be withdrawn, thus exposing the armature for inspection or repair.

The field coils are wound with copper strips bent on edge and well insulated.

The armature spider is of cast iron, and built in two halves to facilitate shipping and assembling. A view of this casting is shown in Fig. 3, and this picture also affords an excellent view of one-half of the field frame. The arms of the spider are cast with splitting plates between them, so as to insure freedom from strains in cooling. They are secured in position on the crank shaft by two heavy mild steel rings, which are shrunk around the bosses at the base of the arms.

On the periphery of this casting are mounted steel punchings, which are suitably notched to receive the armature conductors. These are large copper bars of rectangular section, which are heavily insulated and embedded in the slots. The laminæ on the armature are assembled so as to allow for numerous ventilating ducts, thus enabling the ample passage of air through the core and keeping the temperature of the armature very low. The armature is wound with a distributed closed circuit winding, and the four collector leads draw their current from 124 equidistant points on the winding. The commercial efficiency of each generator is 95 per cent at full load and 91 per cent at half load.

The excitation of these gigantic machines is particularly interesting, as the exciters, which are, of course, machines of small capacity, are connected directly to the engine shaft, the speed of which, it will be remembered, is only 133 revolutions. The direct current dynamos which supply the exciting current at this extremely low speed are shown in Fig. 4. In the large illustration they will be seen connected to the extreme end of the engine shaft. An internal radial pole and drum armature are used. The brush ring is centered in a suitable groove turned in the yoke of the field frame and is operated by a hand wheel and worm, as shown in the picture.

The present contract has a further significance for American industry. The Metropolitan Electric Supply Company is planning new central stations and re-equipping old ones, and the assured success of the engines and generators which have just been described will undoubtedly cause the Westinghouse Company to be called upon to supply much additional engines and generators before the work of reconstruction is complete.

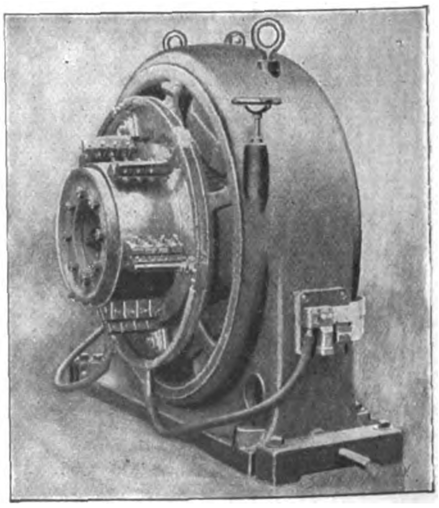


FIG. 4.—EXCITER.

NEW YORK'S ELECTRIC CAB SERVICE.

Motor driven common road vehicles antedate the steam railway. Their development and perfection has been slow and at times almost entirely obliterated by the more rapidly advancing steam traction. We have arrived at an age when mechanical motive powers and common roads and streets are nearing a high state of development and quite warrant the strenuous efforts which have been made within recent years to solve the motor carriage problem.

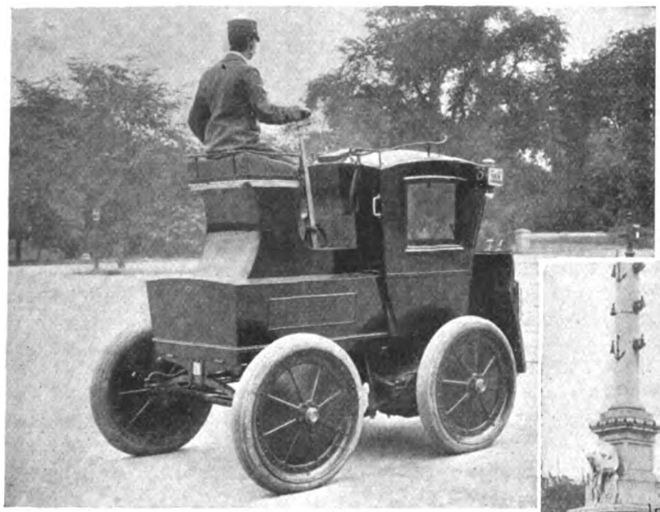


FIG. 1.—SIDE VIEW.

The propulsion of a wheeled vehicle over common roads by means of some self-contained mechanical energy is a very simple matter. Steam, gas and electricity are available as propelling agents, and their proper application to the wheels can be arranged in many ways. There are, however, so many features to be considered and conditions to be met, that as yet no single one of these propelling powers can be said to be universally successful, as the whole production of a satisfactory motor vehicle involves not only the application of a self-contained motive power to a wheeled conveyance, but many other considerations, dependent upon the particular service for which the vehicle is to be used.

Motor vehicles, propelled by steam, gas, electricity and even compressed air and other motive powers, have been produced in untold numbers within the last decade. Many excellent constructions have been evolved, but experience has already demonstrated that with the motors at present available the electric vehicle stands unexcelled, wherever it is possible to replenish the battery charge, and where a long running capacity is a secondary consideration. In such a case the many advantages of electric traction unquestionably overbalance its failings, even taking into consideration the heavy weight of battery equipment.

While electrically driven motor vehicles for private use have been entirely successful, yet it is quite obvious that this type in its present form is peculiarly adapted for public service from a centrally located charging station, the movements of the vehicle being confined to the districts about the station. This advantage of the electric vehicle seems to have been appreciated both here and in Europe, and electric motor cab and carriage services have been instituted in London and Paris. It will be remembered that about eighteen months ago an electric cab service was begun in New York City by the Electric Carriage & Wagon Company, the station being on West Thirty-ninth Street, near Broadway. The equipment consisted of twelve electric hansom cabs, built from the designs of Messrs. Morris & Salom, of Philadelphia. The outgrowth of this pioneer American electric cab service has been the organization of a larger corporation, known as the Electric Vehicle Company, whose recently completed electric cab and carriage plant in the center of Manhattan promises to eclipse the European installations in the completeness of its charging and handling plant and the detail with which the service is dealt. Regarding the old plant, it may be said that the twelve vehicles which it included were in continuous service about the streets of New York for almost fifteen months. They are in excellent condition even at the present day, and though superseded by the improved types, they could be called upon for good work at any time. The new cabs have been built upon the same general lines and are substantially of identical design, such changes as experience has shown to be essential having been made.

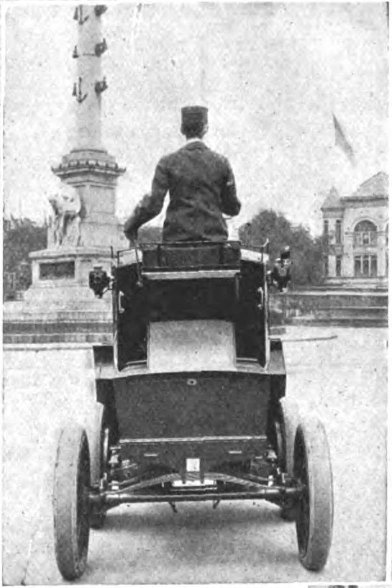


FIG. 2.—REAR VIEW.

The most notable part of the new plant is the facilities for handling these vehicles at the station, which is in striking contrast with the previous installations of a similar nature. Every possible provision has been made for economically and expeditiously charging, loading and unloading the batteries. The following description illustrates the several elements of the completed plant.

The service consists at present of an equipment of 100 cabs, and the aim has been to arrange the handling of the battery equipment so that the combined machinery for the purpose of manipulating it constitutes what may be said to be a single-man machine.

GENERAL ARRANGEMENT OF THE STATION.

The selection of a building suitably located on Manhattan Island was by no means a simple problem. Central location was essential in the district to be particularly covered by the service. This included the theatre, hotel and private residence sections. The very happy selection of the large rink structure of the former Michaux Club, located at 1684 Broadway, and extending through to Seventh Avenue, could scarcely be improved upon. The building occupies about 75 ft. on each of the main streets. Its length is about 200 ft.

The large unobstructed interior offered excellent opportunities for properly disposing the vehicles and their equipment. At the Broadway end a section of about 15 ft., extending the entire width of the building, is used for offices. On the ground floor are located the starter's and superintendent's offices and the waiting rooms, while the engineer's, manager's and auditor's office are on the floor above. A somewhat similar arrangement exists at the opposite end of the building, the ground floor at this end being used for the drivers' room and for storage battery repair, while the upper floor is used as a gener machine shop. The arrangement of the main space is otherwise shown by the illustrations. The battery room occupies almost half the entire floor space; it measures 37 x 100 ft. On each side of this space, running its entire length, is a heavy ste pillar construction which serves as the supporting structure for the battery crane and also for a substantial flooring covering the battery room. This upper floor serves as a carriage storage place. It is the intention to keep the entire unused vehicle equipment

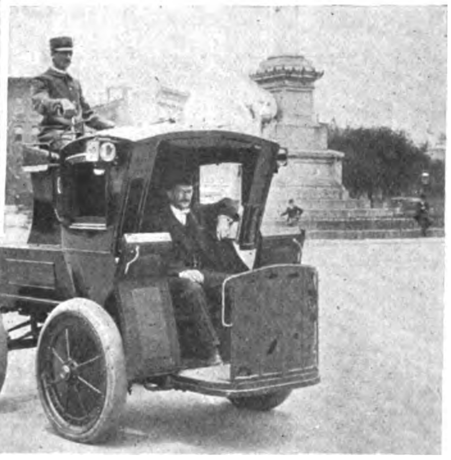


FIG. 3 —FRONT VIEW.

here, with the exception of such as may be on the main floor for the purpose of cleaning and other attention.

Two large vehicle elevators have been provided, one at each end of the battery room.

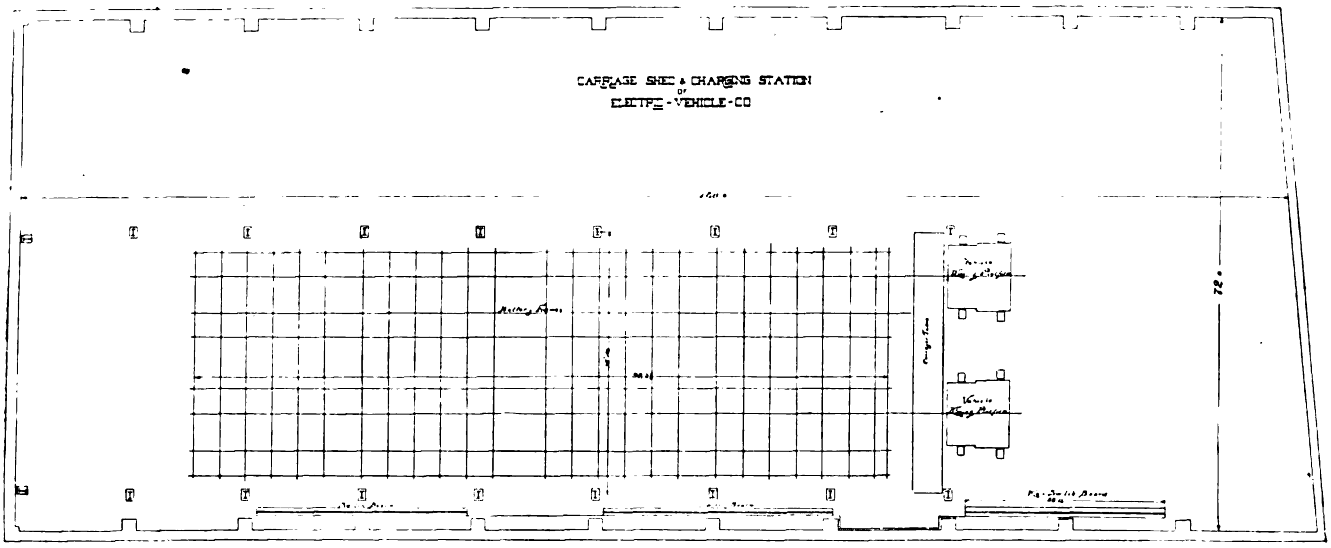


FIG. 4.—PLAN OF STATION.

In front of this room and facing the main entrance is the carriage loading machinery. When loaded, the vehicle leaves the station and accomplishes its mission, returns and is unloaded. Both the loading and unloading are accomplished almost entirely automatically. The carriage backs up against the charging table, its battery is removed and replaced, and the discharged cells are carried back into the battery room and deposited upon the proper racks and automatically connected with the charging circuits. If the vehicle requires attention or is not to be used for a time, it simply discharges its battery and is hauled to the space alongside of the battery room, where it is washed and cleaned and sent back to its resting place on the upper floor by the rear elevator till again wanted. If it is simply recharging, it, of course, receives a new battery. The time required for this operation is exceedingly brief, in fact, the writer witnessed the unloading and reloading of a vehicle which, even with the present somewhat incomplete state of machinery, took only three and one-half minutes. With everything in good working order it is reasonable to expect that the operation can be performed in less than two and one-half minutes.

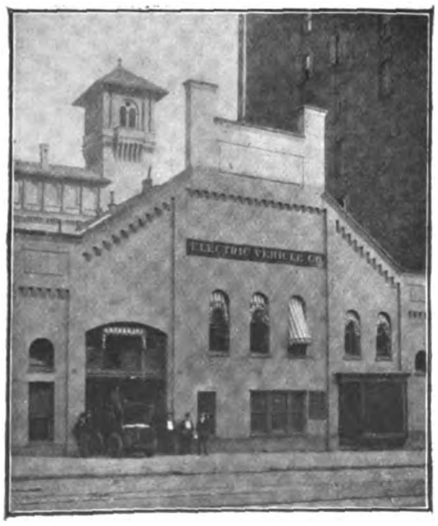


FIG. 5.—THE CHARGING STATION.

THE ELECTRIC HANSOM CAB.

While the 100 so-called electric hansoms are generally similar to their predecessors, a detailed description is perhaps warranted owing to their new features. The body of the cab may be described by simply saying that it resembles the ordinary hansom body with a rearwardly extending box. The latter serves as a battery compartment and also carries the seat for the driver. Aside from the similarity of the fore-body, the electric hansom cannot be said to bear any resemblance to the horse-hauled contrivance. Self-contained motive power essentially demands more than two wheels and more solid construction. The weight of the vehicle, including the battery, is about 2900 lbs. Its length from end to end is 9 ft.; at its widest portion the body measures 5 ft.; the wheel base is 4 ft. 7½ ins., and the gage of both front and rear wheels is 4 ft. 10 ins. In regard to the arrangement of the driving and steering gear the same disposition as in the old vehicles has been adopted; the two front wheels supporting the body proper are used for driving, and the two rear wheels under the battery box are arranged for steering. This arrangement presents a radical departure from common practice. Its designers, Messrs. Morris & Salom, claim that their present construction possesses many points of superiority.

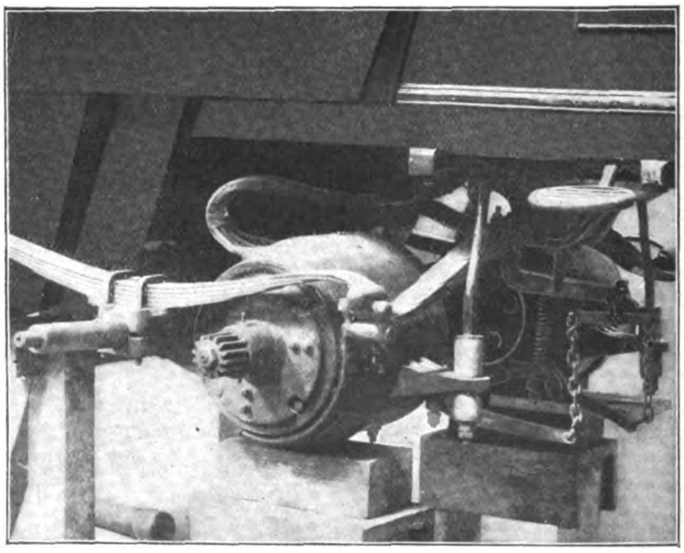
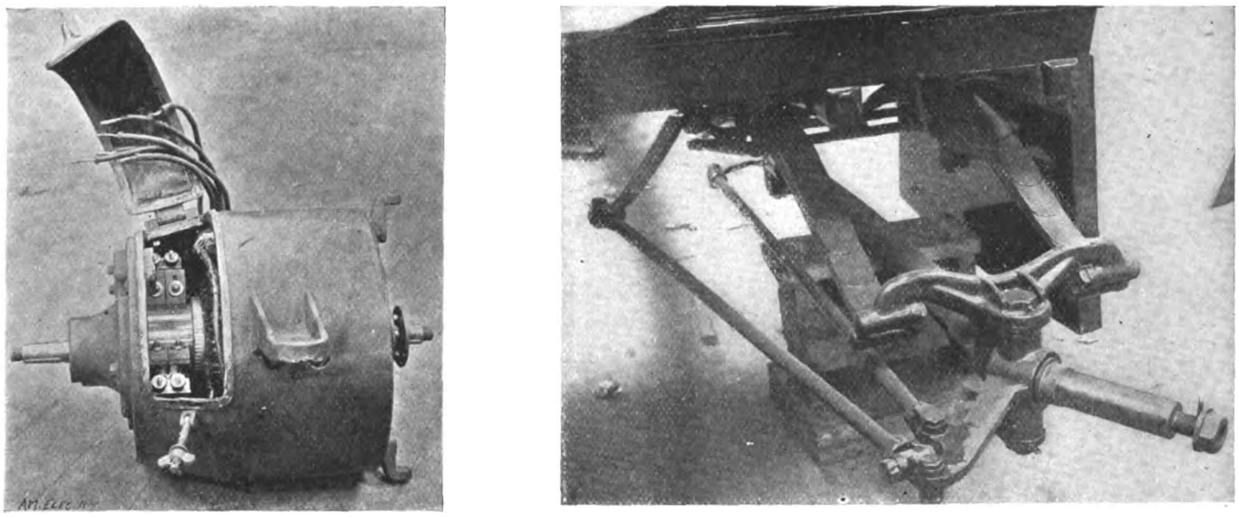


FIG 6.—MOTOR AND SUSPENSION.

Probably one of the most striking features of the construction is to be found in the massive pneumatic tires and the small wheel diameters. Experience with the old vehicles demonstrated the failure of the smaller 3-in. pneumatic tire with which they were equipped, and for this reason the present 5-in. tire has been adopted. These tires are of the single tube type, built by the Hartford Rubber Works and the Newton Tire Company, and are made of ½-in.

rubber hose stock. Larger wheel diameters would have been used, had it been possible to obtain the necessary tires. The present 5-in. tires are pumped to the pressure of 60 lbs. The vehicle wheels are of a somewhat odd construction, being built of two circular plates, serving the place of spokes. These plates are of ⅛-in. stamped steel. They are fastened at their periphery to the convex edges of the metal rim and diverge to the hub, to which they are bolted, leaving a hollow space inside. The over-all diameter of both steering and driving wheels is 36 ins. These wheels weigh approximately 100 lbs. each. Several of the cabs have been equipped with a wooden spoked wheel and the results obtained have been found to be superior.

All four wheels revolve on roller bearings and are arranged with double ball thrusts. The width of the running bearing surface is about 5 9/16 ins. The driving wheels revolve about a fixed axle, measuring 1½ ins. at the bearing ends and centrally fastened at either end to a flat compound spring, upon which the forward end of the vehicle body is supported. Each wheel is separately driven by an independent motor and there is no interconnecting mechanical gearing between them.



FIGS. 7 AND 8.—MOTOR AND STEERING GEAR.

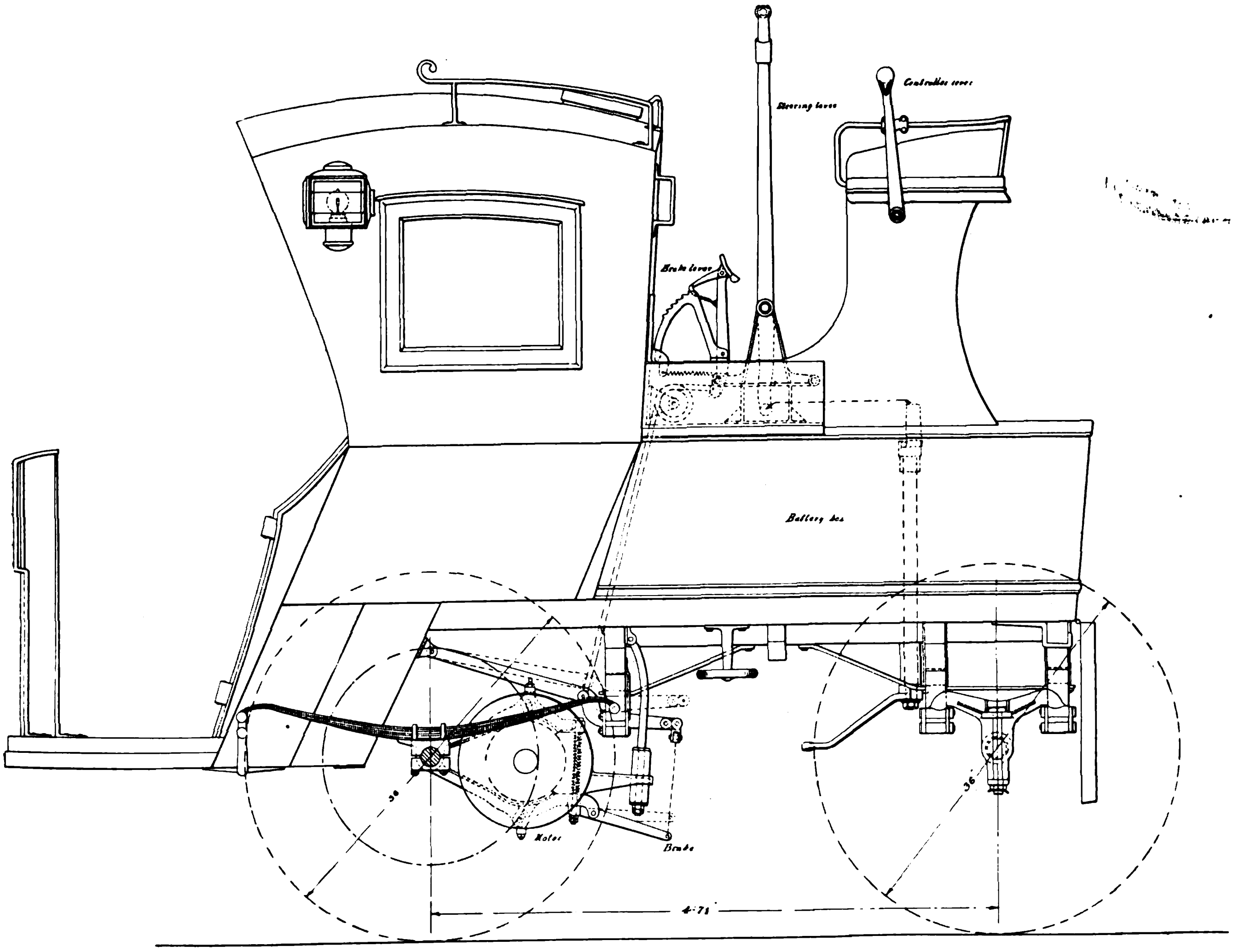


FIG. 9.—ELEVATION OF CARRIAGE.

The series-wound driving motors are of a new water-proof ironclad construction, and resemble in miniature the general type of street railway motor. They were built by the Westinghouse Electric and Manufacturing Company and have a capacity of 2 h.p. at 700 r.p.m. when working at 80 volts, the potential of the battery in each vehicle. With the exception of a small hinged door at the commutator end of the outer casing, the motors are practically sealed. They may be seen to good advantage in Figs. 6 and 7. In supporting these motors and gearing them to the drivers, electric railway practice has been followed. Each motor is pivoted by a projection to the fixed axle, adjacent to its respective driver. A small spur gear pinion meshes into an internal gear, 21 ins. in diameter, attached to the inside of each driving wheel. Thus fitted to the wheel, the gears almost directly transmit their strain to the rim, instead of passing it through the web or hub. At the opposite side of the motor a projecting arm is held between two rubber springs. This motor gearing possesses all the elements of the flexible pivotal suspension.

The steering gear is of the short hub pivoted axle type. Each of the steering wheels rotates on a short axle, which is pivoted close to the wheel hub on the fixed axletree. Arms project from each of the short axles and are connected together by suitable tie rods, which lead to the steering lever in front of the driver's seat. Fig. 8 will assist the explanation. The lever is about 26 ins. from pivot to handle and is moved longitudinally to the vehicle to accomplish the steering. The pivots to the steering axle have been arranged so that their center line almost strikes the wheel contact base. The advantage of this arrangement obtains in the fact that the steering can be rendered more stable by decreasing the leverage between the steering pivot of the axle and the vertical plane of contact on the wheel tire.

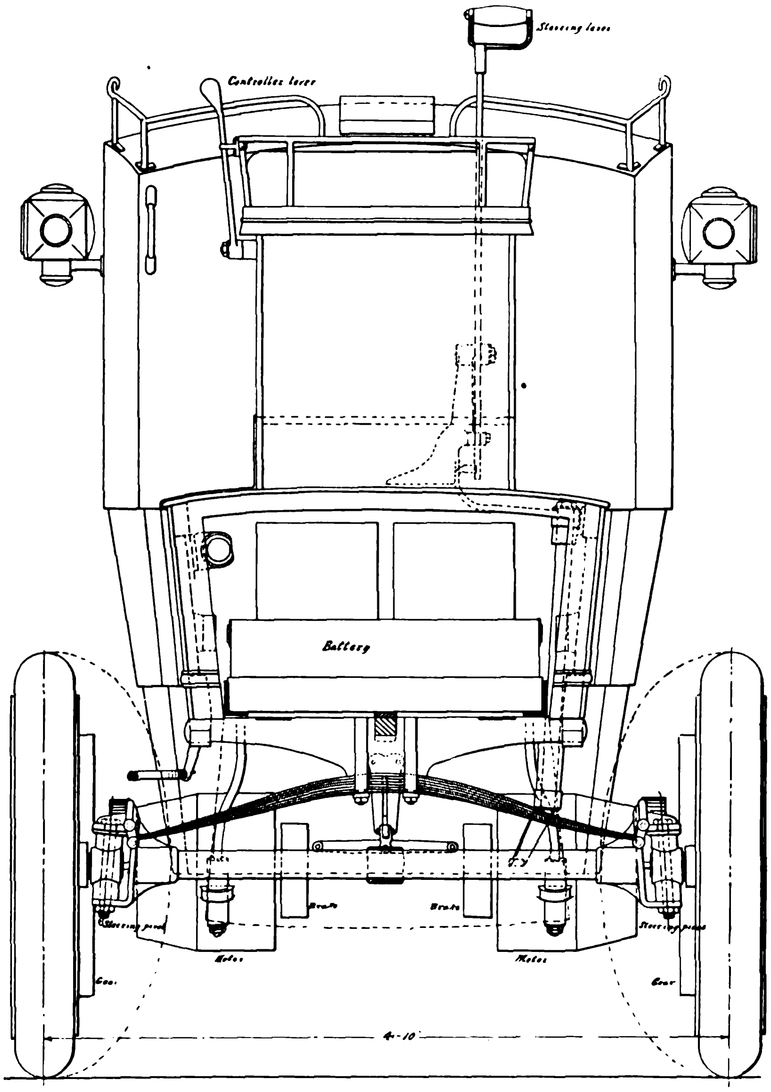


FIG. 10.—END ELEVATION OF CAB.

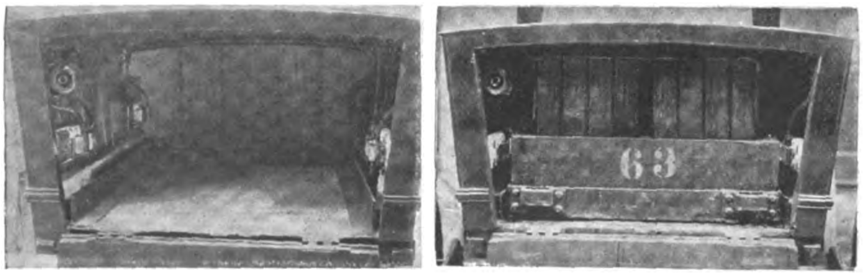


FIG. 11.—BATTERY BOX LOADED AND EMPTY.

A peculiar feature obtains in the arrangement of the under body of the vehicle. It will be noted from the illustrations that each set of wheels is independent. The driving and steering wheels are separately attached to the vehicle body, through the medium of the spring supports.

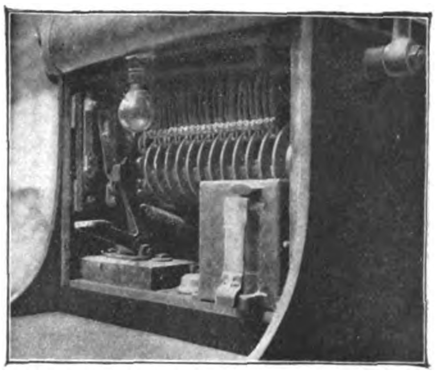


FIG. 12.—CONTROLLER.

Each cab is equipped with forty-eight cells of storage battery. They were made by the Electric Storage Battery Company, and use rubber jars, which contain two Manchester positive and three Chloride negative plates. The battery has a rated output of 100 ampere-hours at the normal discharge rate, but the irregular demands of this service change the rating. Each cell weighs 26 lbs., making the total weight of the battery carried by each vehicle 1248 lbs., exclusive of the holding tray.

An important improvement is to be found in the concentration of the entire battery equipment for each vehicle in a single box, thus making it possible to handle it as a unit. The tray is solidly constructed of wood, well painted and slightly tapered, so as to fit the vehicle box snugly and insure good contact. The battery in its tray measures 26 ins. in width by 3 ft. 3 ins. in length and 16 ins. in height. The connections between the cells are burned together and those between the battery and controller system are automatically made, when the former is placed in position. The automatic contacts engage with four contact strips on the side of the battery box. They have been specially devised and embody several features of merit. The bottom of the battery box is lead lined and provided with suitable drainage channels. The interior may be seen in Fig. 11.

FIG. 13.—CONTROLLER CYLINDER AND HANDLE.

The operation of the vehicle is centered in three controlling appliances, one of which, the steering lever, has already been described. All of those devices are located at the side or in front of the driver's seat. The speed of the motors is controlled by a switch cylinder, placed transversely under the driver's seat and operated by a rotary motion imparted by an upwardly projecting handle. This cylinder is used in combination with the reversing switch, which is provided with levers which can be conveniently operated by the driver's foot. The arrangement is interlocking and therefore it is impossible to reverse unless the controller is at "off." The reversing switch is normally set for the ahead position and so remains, unless pressure is kept upon the operating lever. Three speeds in either direction are provided, namely, 6, 9 and 12 to 15 miles per hour. The various combinations of the battery and motors are shown in the controller diagram, Fig. 15. It will be noted that the battery is divided into two electrical sections, and the series fields are also in sections. Various series and parallel arrangements of the field coils and battery produce the three speeds. With a single charge the vehicle can be operated from 25 to 35 miles, depending upon the character of the roads traversed.

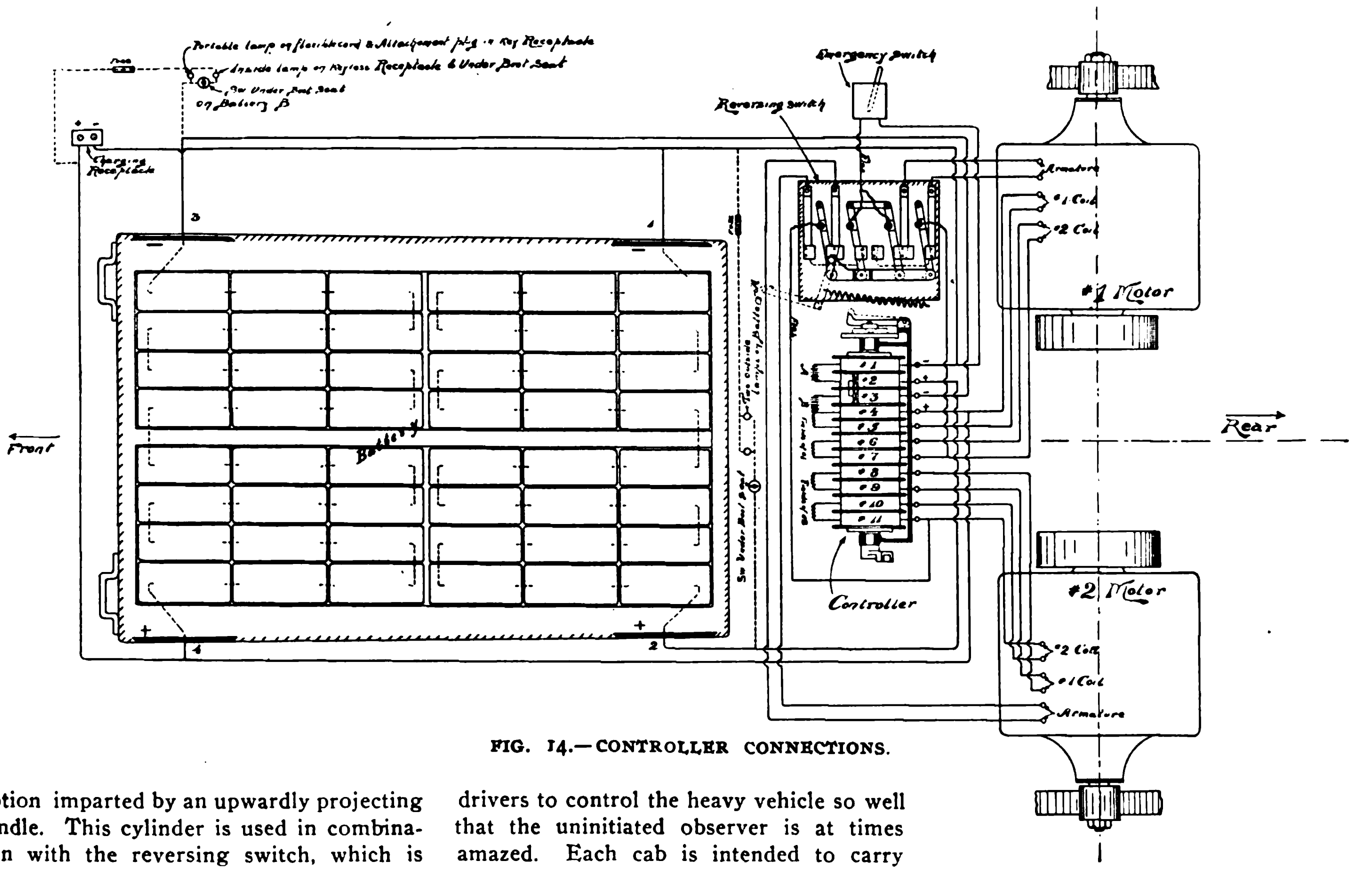

Portable lamp on flexible cord & Attachment plug in Key Receptacle
Inside lamp on Keyless Receptacle & Under Back Seat
Fuse
Sw Under Back Seat on Battery B
Charging Receptacle
Emergency Switch
Reversing switch
3
4
1
2
Battery
Front
Rear
Armature
#1 Coil
#2 Coil
#1 Motor
#2 Motor
#2 Coil
#1 Coil
Armature
1
2
3
4
5
6
7
8
9
10
11
Controller

FIG. 14.—CONTROLLER CONNECTIONS.

An emergency switch is provided, which has a removable key handle and is placed in an easily accessible position near the driver's foot, so that when occasion demands he can move the handle and thus cut off all current. This switch is also used when the driver leaves the vehicle. By removing the handle the switch is opened and cannot be closed until the handle is replaced; this prevents any tampering by unauthorized persons.

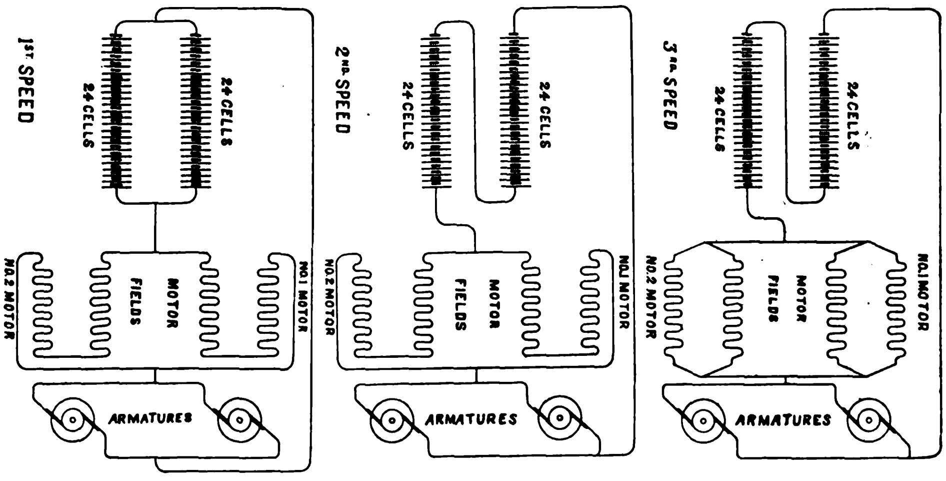

1st SPEED
24 CELLS
24 CELLS
NO.2 MOTOR
MOTOR FIELDS
NO.1 MOTOR
ARMATURES
2nd SPEED
24 CELLS
24 CELLS
NO.2 MOTOR
MOTOR FIELDS
NO.1 MOTOR
ARMATURES
3rd SPEED
24 CELLS
24 CELLS
NO.2 MOTOR
MOTOR FIELDS
NO.1 MOTOR
ARMATURES

FIG. 15.—CONTROLLER CONNECTIONS ANALYZED.

The brake is operated by means of a foot lever and acts upon the armature shaft. It is of the double acting shoe type and is applied to the brake pulley. The brake shoes are in the form of curved levers, one end of which pivots on the axle.

The operator has one foot always on the brake lever and the other ready to operate either the reversing or emergency switch or the bell ringing push. His hands are occupied with the steering lever and the controlling handle. Practice has enabled the drivers to control the heavy vehicle so well that the uninitiated observer is at times amazed. Each cab is intended to carry two passengers and the driver, in addition to such small packages as can be carried on top of the fore-body.

An important feature embodied in the construction of the vehicle and also notable throughout the entire plant, is the duplicate construction of the various parts, including the controller, motors, switches and other parts that are likely to fail and cripple the working ability of the device of which they form a part. The speed controller contact fingers are duplexed so that each terminal from the battery or motor is connected to two stationary contact fingers. Each complete set is arranged in a separate row, engaging with the contacts on the cylinder. The contact plates on the battery tray are also in duplicate. The battery may be charged without removing it from the vehicle by connecting with the charging plug receptacle, fitted in one of the corners of the battery compartment and showing in Fig. 11. This receptacle is conveniently arranged and coacts with a suitable plug attached to the charging mains.

In addition to the hansom cab equipment, other similar vehicles are to be added to the plant. An elegant brougham is an addition. With the exception of the style of body, this carriage is similar in general mechanical and electrical detail to the hansom. In striking contrast with the new vehicles are two of the earlier Morris & Salom electric motor wagons, one being their first production. It is expected to add vehicles of larger capacity in the near future, and several of the omnibus type are being considered.

BATTERY ROOM AND CHARGING ARRANGEMENTS.

The battery equipment for the present service consists of 150 trays, each containing forty-eight cells. This allows 1½ trays per cab, which leaves ample reserve, even though nearly all the cabs should be in service. The disposition of the batteries when not in actual service on the vehicles or when charging is excellent. Owing to the large floor space available all of the battery holding racks have been placed on one level. The battery room is floored with cement, as is also the entire ground space outside. Each tray of battery cells has a separate rack, built of 3 x 4-in. yellow pine, mortised at the joints, held together by wooden dowels, and coated with a good water-proof paint. The height from the floor to the top on which the battery tray is placed is 33 ins.

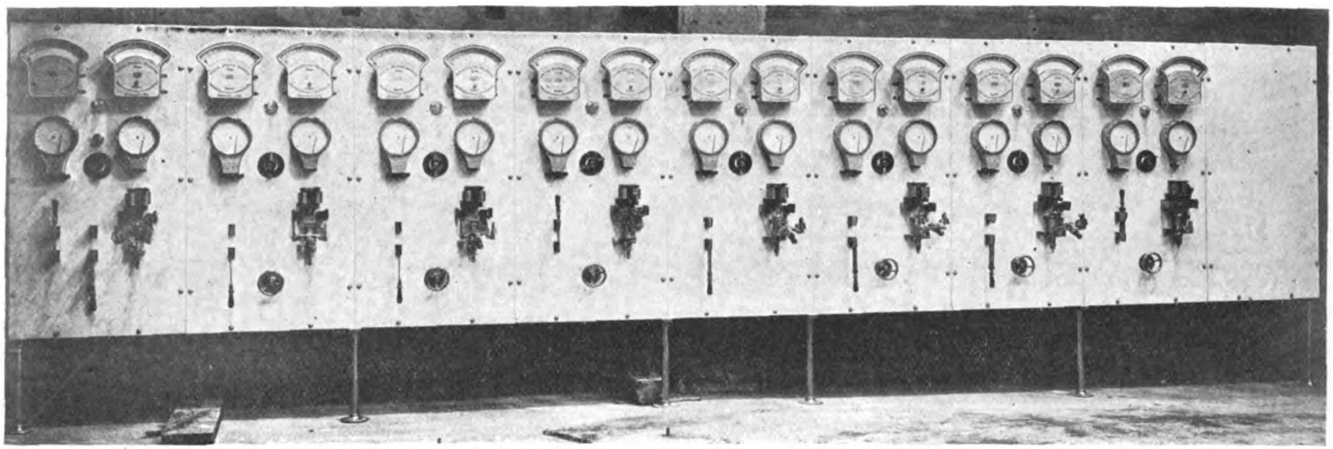


FIG. 16.—MAIN SWITCHBOARD.

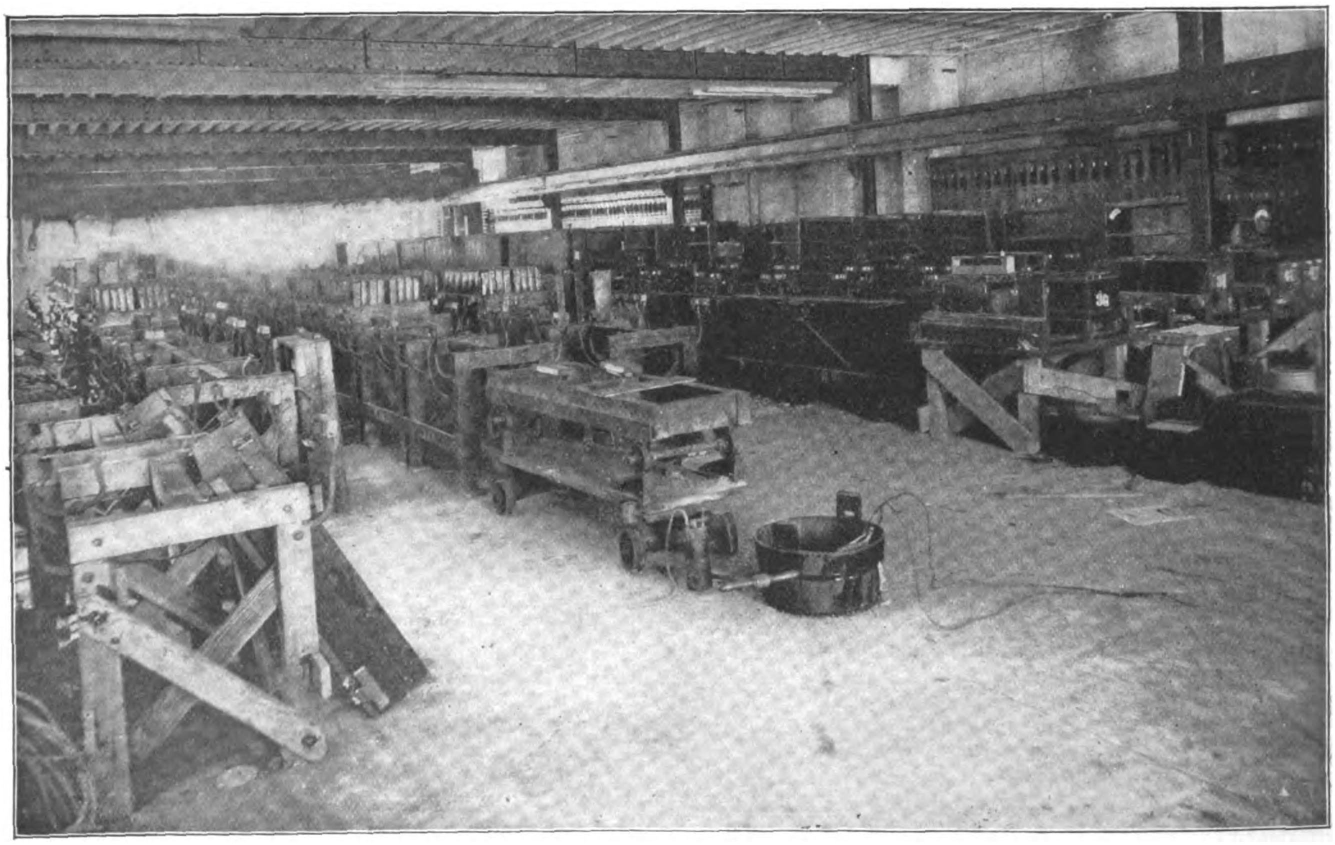


FIG. 17.—GENERAL VIEW OF BATTERY ROOM.

The arrangement of racks is shown in the general floor plan of the station. They range longitudinally from end to end of the battery room in eight rows, with a narrow passage between each row. The central passage is wider than the others, to accommodate the crane cab. There are also three wider passageways transversely across the battery room in addition to those at the ends. Thus, the eight rows are cut into four parts, each containing six racks, which are tied together by wooden planks and rigidly fastened to the floor. This divides them into eight sections, each accommodating forty-eight trays, with the exception of the end section nearest the loading machinery, which has eight additional racks, making an aggregate of 200. These sections are provided with suitable drainage channels, and a large wire channel runs transversely from the charging switchboard on the inner wall of the building along each of the passageways. The lowering of the battery into the rack automatically connects it with the charging wire. At each corner of the rack is a curved lever, pivoted on the side of the upper timbers. The upwardly projecting ends are fitted with insulated spring contact straps, and when the lever is moved these describe an arc, thus bringing them in contact with the connecting plates on the ends of the battery tray. The weight of this end of the curved lever causes it to swing free when the cells are raised. The other end of the lever is quite short and projects an inch or two above the top of the tray supporting timbers. When the battery is lowered its weight strikes upon these projecting ends, causing the other ends to spring up and make secure contact with the plates on each side of the tray.

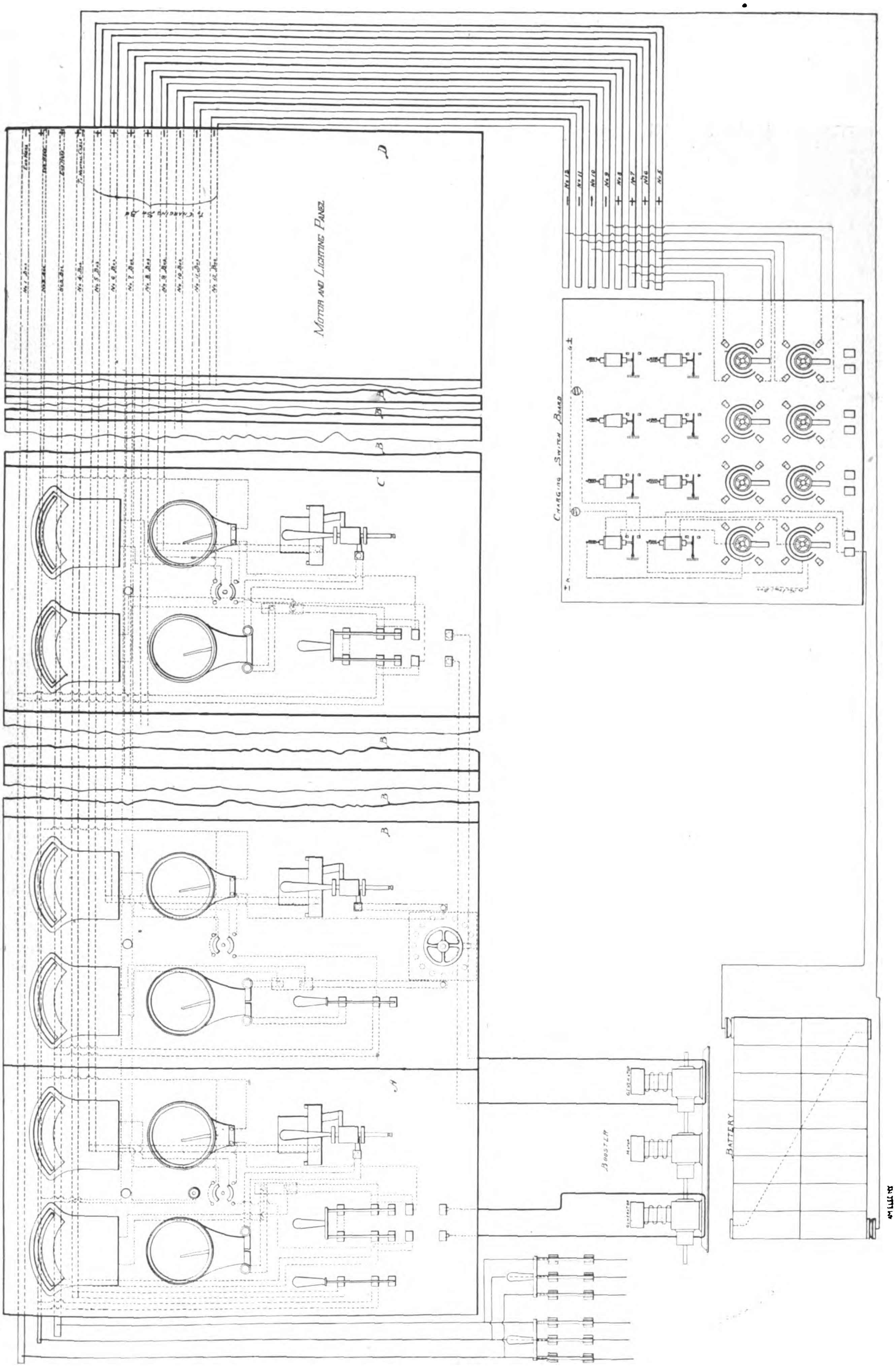

MOTOR AND LIGHTING PANEL
D
C
B
A
CHARGING SWITCH BOARD
BOOSTER
BATTERY
No. 12
No. 11
No. 10
No. 9
No. 8
No. 7
No. 6
No. 5

FIG. 18.—CHARGING CONNECTIONS, MAINS TO BATTERY RACK.

As the cells in each tray are divided into two sections, it is necessary to provide each rack with four of these automatic contacts. This is clearly shown in the photograph, Fig. 19. The charging wires are connected to two diagonally opposite contacts, and the other two are cross-connected by a flexible rubber insulated cable. This connects the entire forty-eight cells in series across the line.

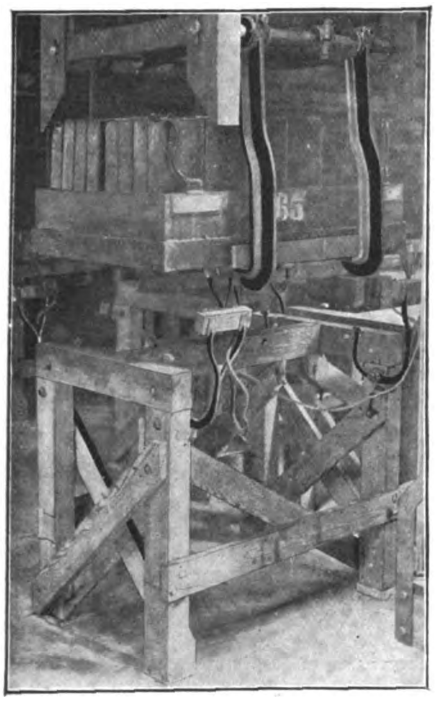


FIG. 19.—BATTERY RACK.

Instead of furnishing the charging current from an isolated generating plant in the building, it has been found preferable for the present to take the supply for charging the batteries and operating the various motors from the Edison street service. This choice might, at first sight, seem to be less economical, but it must be remembered that the cost of the current for charging the battery is but a small percentage of the entire cost of operating each vehicle and the rates for current for such service are comparatively low.

At the Broadway end of the building two three-wire 350,000-c.m. service connections are brought into the north wall, whence they connect through three pole switches to cables of 1,500,000 c.m. capacity leading to the main switchboard, which is located between the battery room and the offices. This main board is made up of nine white marble panels, each 3 ft. long, making the entire length of the board aggregate 27 ft., with a height including the supports of 8 ft. At this board the three-wire street service connects through the medium of the appliances on the panels to a series of buses of raised or lowered potentials. These buses of various voltages are carried to the battery charging panel further on in the battery room. The connections of the main board, as well as the charging board in the battery room, are shown in the combined diagram, Fig. 18. The neutral wire of the service simply passes through a single pole switch on the first panel to the left, and from thence directly to the charging racks, where it connects at each rack with one of the previously mentioned automatic contacts. The first four panels to the right of the main board control charging buses connected to the positive side of the service, while the succeeding four control negatively connected buses. The battery racks are connected to both the positive and negative charging buses through the switches on the charging board. The buses are thus connected at their respective panels through a single pole switch, an under-load or over-load, I. T. E. circuit breaker and a large rheostat, whereby the potential may be lowered to any desired extent. This arrangement is the same with all of the charging panels, except the first and fifth, which are arranged to boost the potential of the connecting charging buses, or keep them at the same point as the street service. In this case the rheostat is omitted and a double-throw pole switch is installed, which throws the buses in series with a boosting dynamo, or simply connects directly to the service buses. The capacity of the instruments on each of the charging panels and their respective buses, ranges in steps of 100, from 100 amperes for the high pressure panel to 400 for the low. The last panel on the right is to be used for light and power switches and instruments.

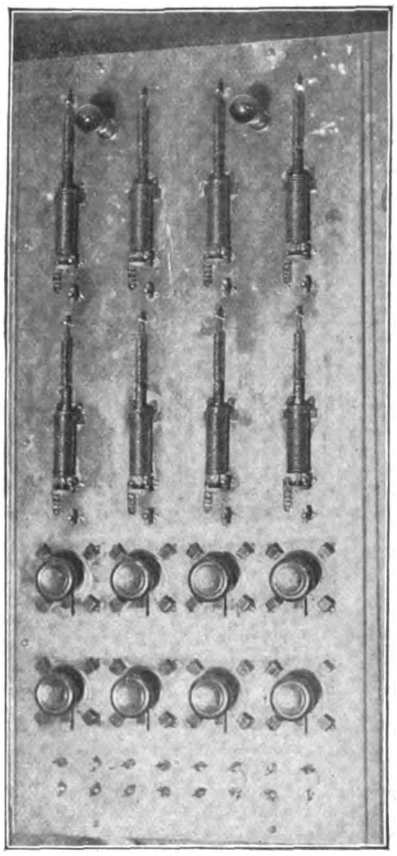


FIG. 20.—CHARGING PANEL.

The booster equipment consists of a 7½-h.p. 220-volt multipolar motor, centrally placed between two bipolar booster dynamos, as shown in Fig. 21. The armatures are directly coupled together. One booster raises the potential on the positive bus, and the other is used on the negative side and the capacity of each measures 200 amperes at from 5 to 15 volts. These machines were built by the Western Electric Company, and are placed on a heavy wooden platform above the switchboard.

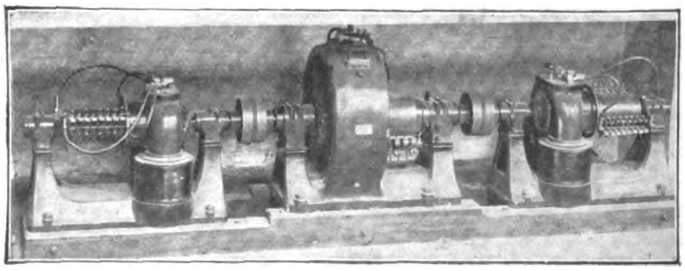


FIG. 21.—BOOSTER.

The object of the various charging buses will be apparent on examination of the charging panels. These are arranged in two groups in the battery room. They are built of heavy slate slabs, measuring 30 ins. x 60 ins. Each panel is equipped with the instruments for eight charging circuits leading to the racks. A separate wire from each battery rack extends in a lead armored cable laid in the previously mentioned trenches to its respective panel section. Each battery wire connects through a form of solenoid ammeter to a four-point switch arm, whereby it can be connected to any one of four charging buses. The upper row of ammeters and switches is connected to the positive buses and the lower row to the negative. In charging, a battery is connected, first with the lowest bus through the four-point switch and gradually worked up until the highest bus is reached. To govern the changing from one bus to another according to the current fed to the battery, the ammeters are provided with a tell-tale lamp indicator, which is set at charging current, 20 amperes low and 50 amperes high. Should the current fed to any battery reach these extremes a red or green incandescent lamp is lighted. Only one set of lamps is provided for each panel, and the lighting of the low range lamp shows that one of the batteries on that panel has fallen below the 20-ampere point and must be connected to the next bus. The only attention necessary is the shifting of the charging switches from time to time, and this is done by the man who operates the crane and loads and unloads the vehicles. In fact, he can control the entire equipment, almost without leaving his station on the crane cab.

To withdraw the fumes from the somewhat inclosed space which comprises the battery room, a 40-in. exhaust fan is placed on the upper floor and operated by a belted electric motor. The fan suction flue originates about the center of the partition wall, while the outlet is brought to the roof.

On the outside of the partition wall at the forward end of the battery room, charging receptacles are placed, so that any vehicle may be connected with the charging wires without unloading its battery. Batteries so connected are manipulated in the same manner as if they were on their racks in the battery room.

THE MECHANICAL MANIPULATION OF THE BATTERIES.

The most important element in this installation is the battery handling machinery. The various parts form practically one machine, which is manipulated by a minimum of manual labor, and is certainly worthy of much favorable comment. The work involved in handling a vehicle includes the carrying of the battery from the rack to the loading point, and here, after proper alignment, pushing the battery into its compartment. In unloading these operations are reversed. The battery is moved from the rack to the loading point by means of a novel electric crane, carrying eight electric battery hoists. This crane has a capacity of eight tons and runs the entire length of the battery room, which it spans from side to side. On each side of the operating cab, which is centrally suspended from the bridge and almost touches the floor, are the battery hoists. These are placed side by side, four on each side of the cab, and come directly over each row of battery racks. Fig. 25 will assist in comprehending the arrangement. Each hoist has a capacity of one ton and works in conjunction with a novel lifting and lowering grapple, which automatically engages with the battery tray. The grappling arrangement consists of two heavy iron jaws which are raised or lowered by two chains, one of which performs the hoisting and the other manipulates the grappling arms. The drums for each of these hoists are operated by a separate worm-geared motor. In raising a battery from the racks the grapple is lowered in its open condition until it reaches the limit of the chain, which is set so that the arms are then just below the bottom of the tray. The further rotation of the hoisting drum winds the chain up again, closes the grappling arms around the bottom of the tray and raises it to the desired height. The operator in the cab simply starts and stops the motor, which runs in one direction only and does the rest. The battery is now carried to the loading transfer table, which is also electrically operated. This mechanism is really a link belt conveying machine and extends across the entire front or loading end of the battery room. It consists of heavy iron crossbars with upward projections, forming the sections into which the tray fits. The battery is lowered and deposited in one of these carrying sections of the conveyor. The lowering and releasing is the reverse operation of the raising and is accomplished by an opposite rotation of the hoisting drum. The transfer of the battery tray from the conveyor table to the vehicle compartment is accomplished by hydraulic machinery. In front of the table are two vehicle loading and unloading platforms. Each of these platforms is composed of two wooden flat carlike structures placed side by side, so that their platform is on a level with the cement flooring of the station. The wheels upon which these platforms are placed run on parallel tracks in the platform pits, the motion being in line with the conveyor table. Each half of the loading platform has four wheels and the two parts are automatically aligned with each other and centered by means of suitable weights. The vehicle backs onto the platform, so that each pair of wheels has a movable car to itself; and the vehicle can then be shifted from side to side and suitably aligned with the conveyor rack. Another alignment is necessary to level the bottom of the battery compartment, due to the change in the level of the vehicle battery box, when loaded or empty. In fact, this part of the vehicle sinks several inches by reason of the compression of the springs and pneumatic tires.

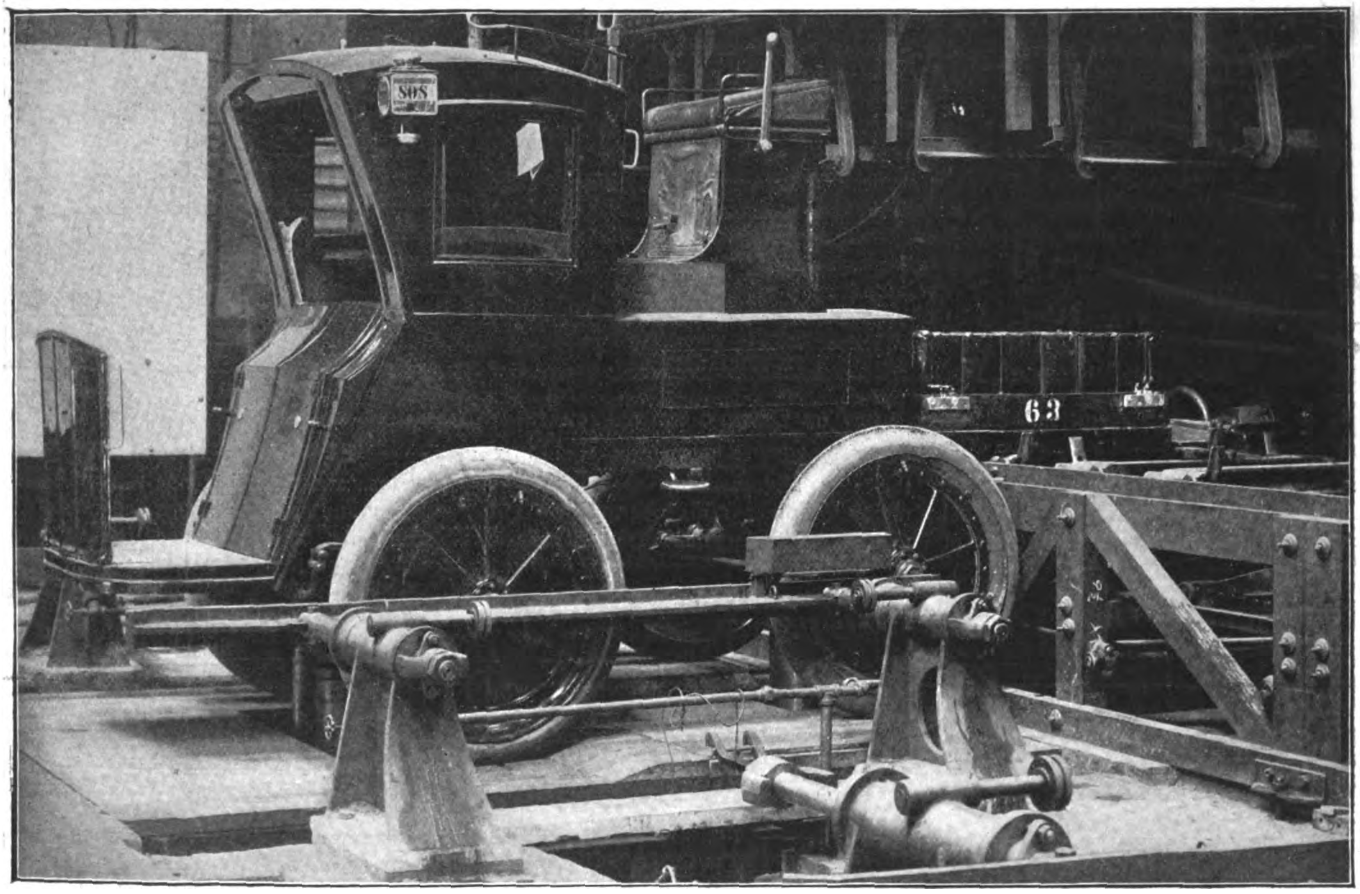


FIG. 22.—CAB IN LOADING POSITION HELD BY HYDRAULIC RAMS.

The vehicle is run into this position with the rear door open, and when thus aligned and leveled is ready to have its tray of batteries pushed from the table into the battery compartment or pulled out of the latter onto the table. These operations are performed by means of hydraulic rams from a point centrally located behind the table. This hydraulic machinery is shown very clearly in the illustrations, Figs. 24, 26 and 28.

Under each of the two parts of the moving vehicle platforms hydraulic cylinders are vertically placed. The plungers are attached to suitable raising bars, upon which the vehicle body rests while loading. These parts are normally below the surface of the platform, but when actuated are projected through an opening about in the center of each half, which is covered by a series of small hinged trap doors. These rams raise the vehicle, and when the elevating plunger parts are projected upward, the battery compartment is raised clear of the springs by the one and the hansom body by the other. After the vehicle body has been lifted, which constitutes the first operation, the side alignment is accomplished by means of other rams operated on either side of the loading platform. These bars act at about the hub centers of the wheels and extend horizontally so as to strike both steering and driving hubs close to each end. The bars are connected to the plungers of the horizontally placed ram cylinders. The two centering rams attached to each bar have different movements, the one opposite the front wheel having a travel of 11 ins., and the other one 7 ins. Both the lifting and centering rams act in one direction only, being returned to their normal position by heavy weights. The hydraulic rams and lifts are all mounted on solid masonry piers and their movement is a definite predetermined amount, and raises and

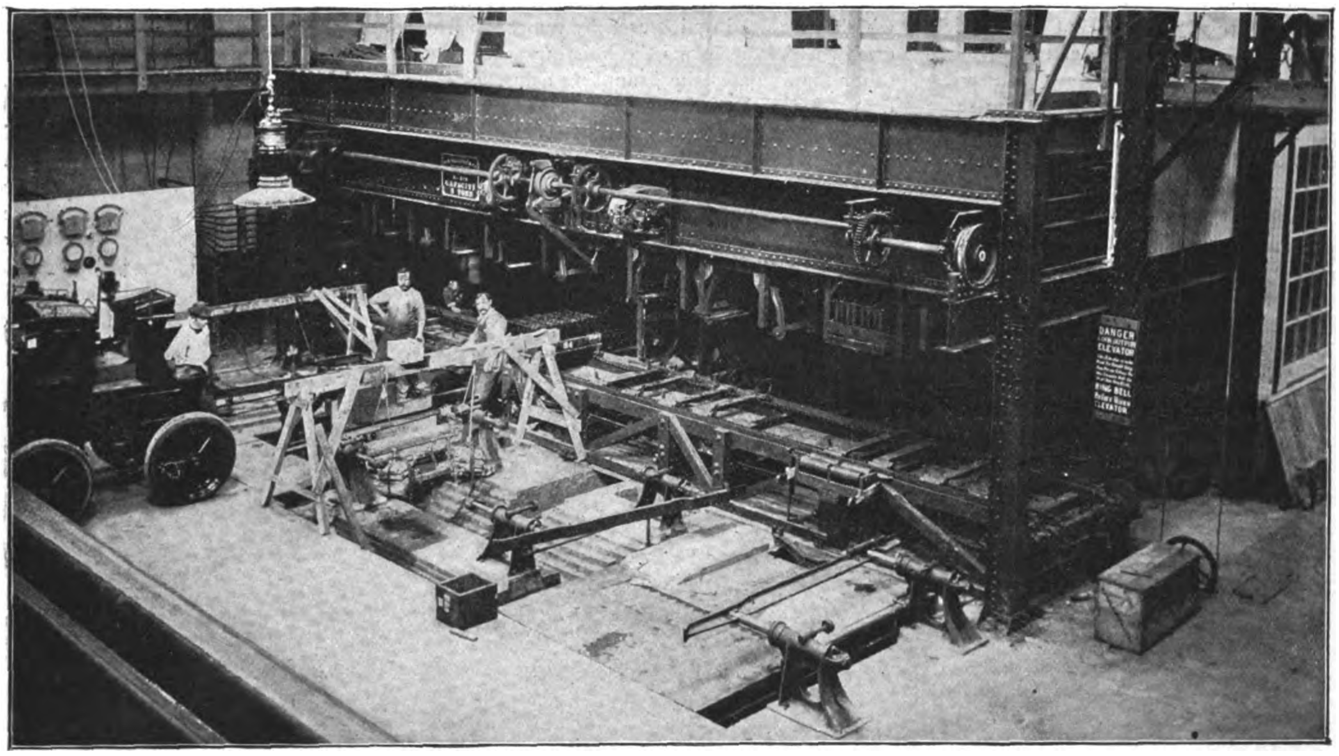


FIG. 23.—GENERAL VIEW OF LOADING STANDS, CRANE AND TRANSFER TABLE.

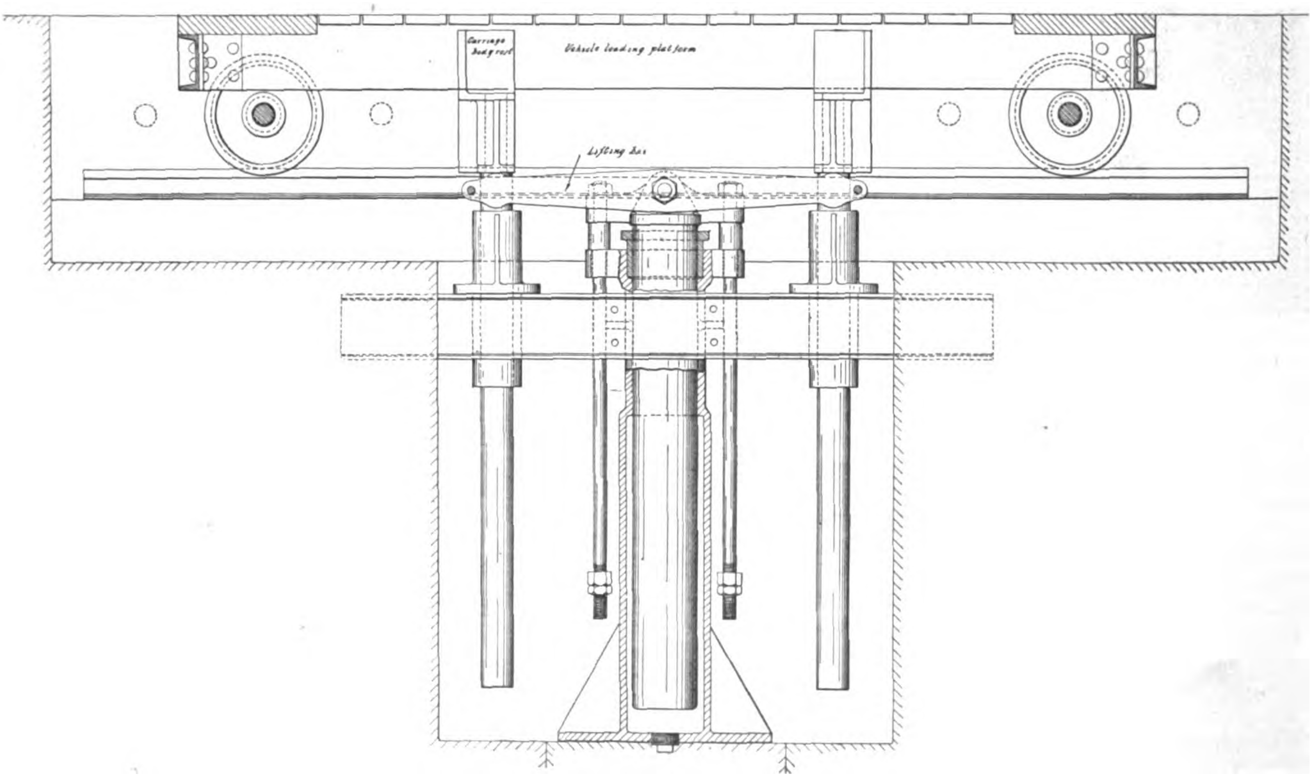


FIG. 24.—ELEVATION OF LIFTING RAM.

centers the vehicle to exactly the desired position.

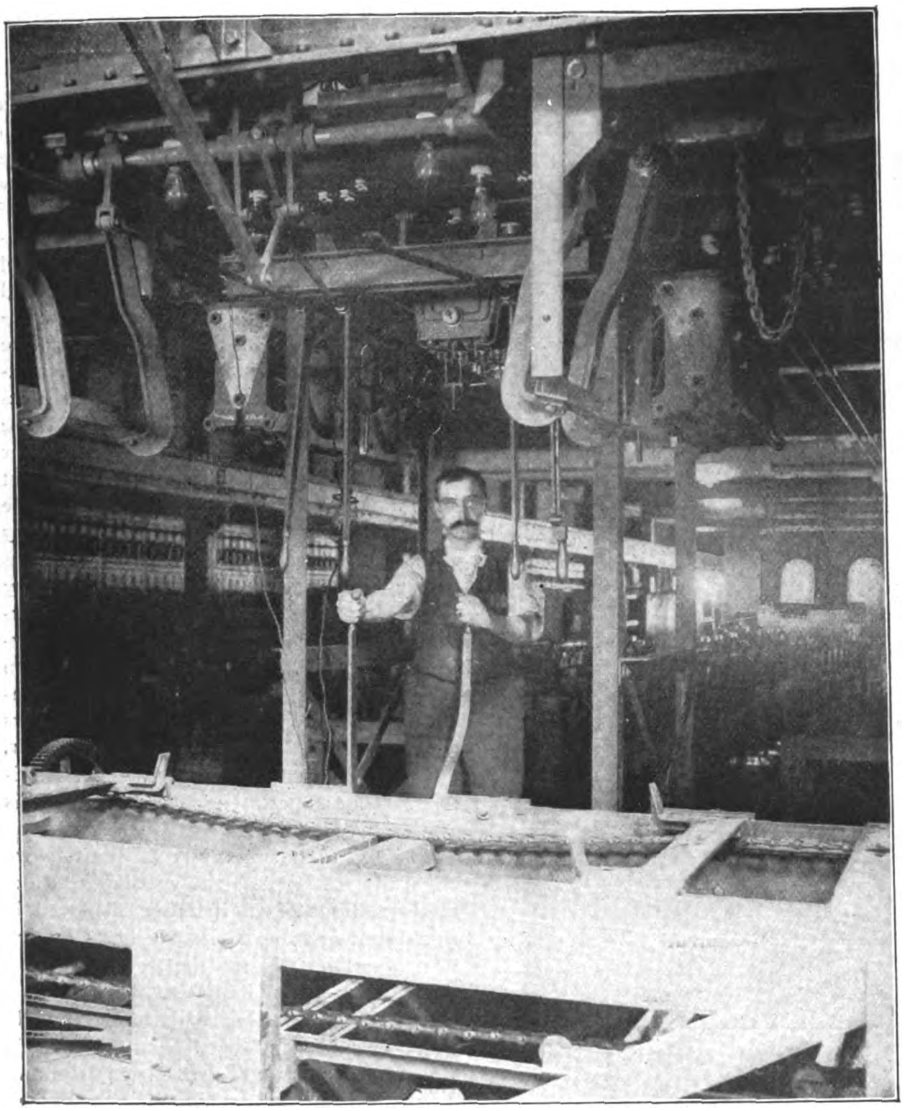


FIG. 25.—CRANE CAB, AND TABLE CONTROL.

In the rear of the conveyor table, placed horizontally in line with the center of the loading platform, is a long hydraulic pushing and pulling ram; its cylinder is on a level with the top of the conveyor table, across which the long plunger is projected, and in the loading operation simply pushes the tray into its compartment. If the battery is to be unloaded the plunger is extended so that a pair of hooks at its ends automatically engage with sockets on the end of the tray, and the return of the plunger pulls the tray onto the conveyor table. The hooks are released by means of a lever at the rear side of the table, which is accessible to the man in the crane cab. After loading or unloading, the hydraulic machinery is returned to its normal position and the vehicle leaves the platform.

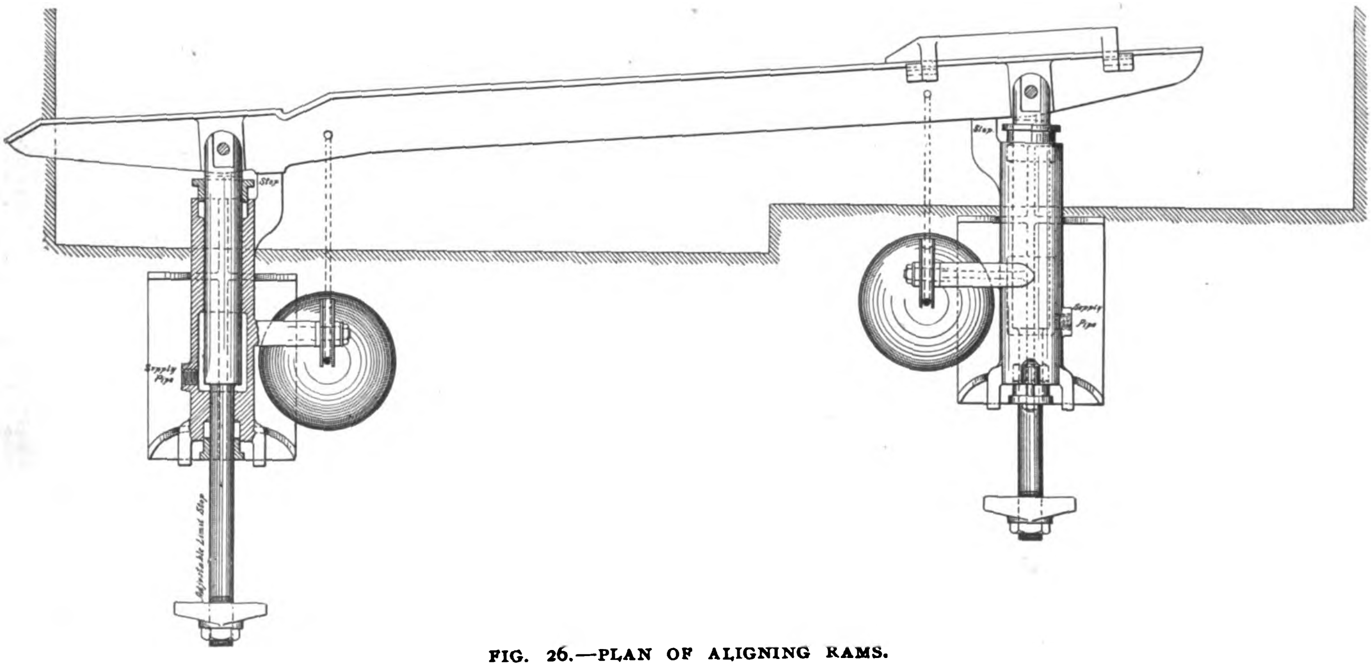


FIG. 26.—PLAN OF ALIGNING RAMS.

An excellent example of the possibilities of concentrated control is exhibited when this machinery is set in action by the crane operator from his position in the crane cab. At the top and sides of the cab are arranged the various switches and rheostats for the hoist and driving motors. Having carried the battery to the conveyor table the crane operator finds himself directly in the center of the latter, and at this point are the handles for its manipulation and the valves controlling the hydraulic cylinders, all of which can be operated without stepping from the crane cab. His position in the crane cab is shown in Fig. 25, and it will be seen that the operator can easily watch the telltale lamps on the charging panels. The batteries are transferred from one line to another by bringing them to the conveyor table and shifting them in line with any hoist. The crane, which, by the way, was made by William Sellers Company, of Philadelphia, as was also the conveyor table, is operated by Westinghouse four-pole motors, each of 5-h. p. capacity, and alike in all respects. This arrangement makes all the motors interchangeable. For the operation of the crane bridge and the conveyor table a double motor equipment is used, which further insures continuous operation. The current for the crane motors is taken from the trolley wires suspended above the crane bridge.

For the operation of the hydraulic machinery an electrically operated Gould triplex pump is used. This pump is placed at the wall end of the conveyor table and feeds a pressure tank, from which pipes are extended to the various controlling valves, located as has already been described. The water is taken from a tank 3 ft. in diameter and 5 ft. deep, sunk in the floor between the loading platforms, and is returned after being used. The working pressure is 150 lbs. to the square inch.

In addition to the loading stations just mentioned, an emergency loading station has been provided at the side of the battery room between the two vehicle elevators. No arrangement is made at this station for side centering, but the lifts and loading cylinders are arranged as in the others. At this station the battery tray is carried on a car to the rear of the vehicle, where it is handled by a loading and unloading ram, as previously described. The tray carrying car runs on a track extending from this loading station transversely across the battery room, and the handling of the battery by the crane from and to the car will be obvious from prior description. The car with one tray can be set in line with any of the eight rows of battery racks.

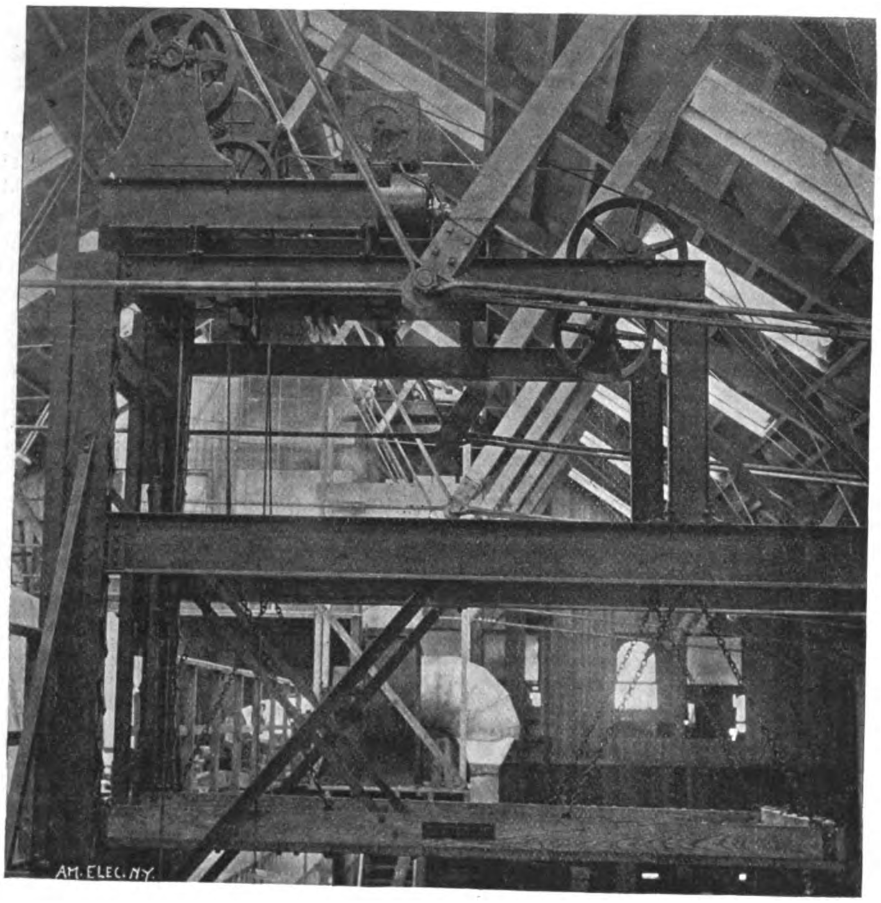


FIG. 27.—VEHICLE ELEVATOR.

The operation of the elements of this machinery is greatly aided by a number of interlocking safeties. On the crane an interlocking device co-acts with notches in the track girder and only permits of operating the hoists when they are properly centered over the battery racks or the conveyor table. The hoisting motors are also locked with the crane bridge motor, so that the latter can only be operated when all the hoists are up and clear from obstruction. The conveyor is provided with automatic motor stops at each end, so that the battery cannot be carried over the ends, and it is also interlocked with the loading machinery, so that the conveyor cannot be moved when the loading ram is in action, or vice versa. There are two vehicle elevators operated by worm gear electric motor drum hoisting machines. Each elevator has a capacity of 2½ tons and operates at the rate of 100 ft. per minute. They are controlled by rope operated starters. C & C motors are used.

SOME FEATURES OF THE PLANT AND ITS SERVICE.

As with other commercial enterprises, the question of revenue is the prime consideration. For this reason the aim has been to economize in the handling of the vehicle at the station, and that this has been well accomplished will be appreciated from the foregoing. The handling of the vehicle, aside from the loading and unloading, is simply a matter of unskilled labor and very little of that. If the vehicle is to be stored after unloading, it is washed as any other carriage would be and sent to the upper floor by the rear elevator. As the vehicles are wanted they are lowered by the forward elevator. Each cab is inspected by the starter before leaving the station and a record taken of its battery equipment. With the desire to increase the efficiency of the service a series of vehicle tests will shortly be inaugurated. This will include tests of current consumption under different conditions of running, speed on grade and level, and traction tests. Various special and standard testing instruments have already been arranged for this purpose. The bid for business seems to have been directed in the right direction. Rates for electric cab hire are almost one-half those asked for the horse-drawn service. For each single passenger, 30 cents for the first mile and 15 cents for each succeeding mile is charged, or the cabs may be hired by the hour at special rates.

The Electric Vehicle Company is worthy of the highest commendation for pioneering the electrical vehicle service on so magnificent a scale. The investment has been large, and it is to be hoped that the venture will prove remunerative. The officers are: Mr. Fred Vieweg, General Manager, and Mr. G. Herbert Condict, Chief Engineer. The superintendent of the plant is Mr. W. T. Headley.

In closing it is but just to say a word regarding the persons to whom the thorough methods of engineering displayed in this station are due. Mr. G. Herbert Condict, who is responsible for the general station design, was assisted by Mr. A. W. Gilbert, the constructing superintendent. It is to be sincerely hoped that the electric motor cab service will prove successful and further advance the emancipation of the horse.

AMMONIUM-CHLORIDE ACCUMULATOR WITH CARBON PLATES.

BY PROF. WILBUR M. STINE.

A reference is made on page 333 of the July issue of the "American Electrician" to a form of accumulator whose elements are simply carbon plates immersed in an electrolyte of ammonium chloride. Some rather remarkable statements are made by the inventor, Señor A. Sandaran, not only concerning the efficiency and ampere-hour

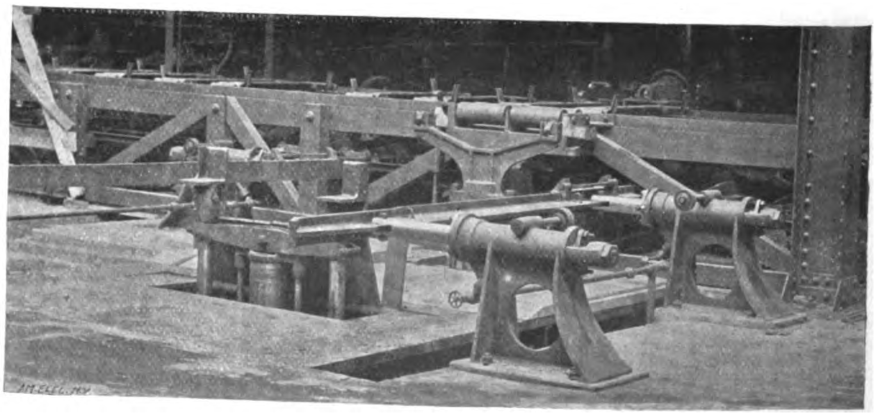


FIG. 28.—LOADING TABLE, SHOWING HOISTING AND ALIGNING RAMS.

capacity of the cell, but its permanence of charge as well. According to the stated data, a h.p.-hour seems to have been stored for each 7 lbs. gross weight of the cell (?), making this type probably the most remarkable one on record.

The article recalled to the writer some investigations made during the early part of 1891, and as the results were published at the time, Señor Sandaran's battery has been anticipated by at least seven years.

At this time the writer was engaged upon an extended investigation of the absorption of carbon elements for electrolytic gases and the utilization of this principle for the storage of electrical energy. Some of these results may be found in the "Voltaic Cell," by Park Benjamin, page 323, while others were embodied in a paper before the A. A. A. S., and printed in its Proceedings for 1891. On page 146 of this volume the following occurs: "A large cell on the same plan was prepared with carbon dust and saturated with a 20 per cent solution of NH_4Cl. As was expected, this cell proved capable of receiving a considerable charge without gassing. The potential immediately after charging was 1.7 volts, which invariably fell to less than 1 volt on standing twelve hours. The cell was varied and many tests applied; the results were encouraging and seemed to indicate that it might be a good type to develop for some purposes, as it is light and inexpensive."

Such cells were set up in the ordinary gravity battery jars of the size 6 ins. x 8 ins., and weighed in some cases about 15 lbs. Carbon plates 2½ ins. x 8 ins. x ¼ in. were used for the electrodes. One plate was placed in an ordinary porous cup and packed with some form of granular carbon. The cup was then placed in the jar, the other carbon plate added, and the remaining space was filled with similar granular carbon. The granular carbon was packed to secure electrical contact, but care was taken not to make it too solid and nonporous. This carbon was previously well washed, that the electrolyte should wet it thoroughly. One object in these tests was to ascertain the form of carbon most absorbent under such conditions; granular carbon such as is used for making arc-light carbons; animal charcoal, whose mineral constituents had been removed by acid treatment; and willow charcoal were successively employed. The treated animal charcoal gave excellent results, but the granular arc-light carbon was several times as efficient.

Though the polarity of the cell was varied, the greater capacity resulted when the electrode in the porous cup was the positive one on charging, due doubtless to the fact that the gaseous products of electrolysis about the negative electrode are less soluble and absorbent, and consequently more carbon surface is required. Various strengths of charging currents were tested, ranging from .02 to .5 amps. per square inch of active surface; decidedly superior results were obtained with low current density, since it requires considerable time for the gaseous products to be absorbed or pass into solution, otherwise the cells gassed violently, especially toward the end of the charge. Even with the lowest current densities the cells gassed considerably on charging, and the odor of the gases emitted was extremely offensive and the fumes were irritating. At the time it was concluded that these features were principally due to chlorine gas and its oxides. These fumes were so irritating and unhealthy that it would scarcely be possible to operate many such cells in a battery room.

When the cells were discharged immediately their action was energetic and the internal resistance reasonably low, but the e.m.f. was not well sustained. Upon standing they rapidly lost their charge, and in the course of twenty-four to thirty-six hours they became completely discharged. Their ampere-hour capacity was in all cases low, and in no instance is it recalled that it exceeded twenty units, while the watt efficiency due to secondary chemical reactions was very low.

The electrolysis of NH_4Cl produces complex and rather obscure chemical reactions. Apparently the radical NH_4, ammonium, comes off at the negative plate, splitting up into NH_3, ammonia, and free hydrogen, the ammonia dissolving into the water and the hydrogen being partially absorbed by the carbon present and partially escaping; the chlorine evolved at the positive plate passes into solution and is probably partially absorbed. On discharge these various products would recombine. But there immediately follows a complex set of secondary chemical reaction, whose exhaustive discussion is scarcely warranted in the present article. One point of considerable interest is that nascent oxygen results at the positive plate and attacks this so vigorously that the plate is rapidly disintegrated. This fact in itself would doubtless be fatal to the commercial success of such cells.

In any form of gas battery the gaseous chemical compounds or elements act only in solution. This accounts for the rapid decline of the e.m.f. on discharge; the electrolyte soon becomes impoverished, especially in hydrogen, which is only slightly soluble; in general, the gases occluded by the carbon pass into solution with considerable slowness.

The fall of e.m.f. then, is strictly not due to an increase of internal resistance. At present it seems impossible to construct such cells that they will not be very unstable, and rapidly lose their charge on standing out of action. Owing to osmosis and diffusion the dissolved products of electrolysis, such as ammonia and chlorine acids, will rapidly permeate the entire cell and recombine, and the charge thus be lost.

The results obtained do not indicate that such cells have a commercial value. They are inexpensive and no doubt can be made much lighter than the given capacity of ordinary lead storage battery. The rapid deterioration of the positive plate, the offensive and unhealthy fumes given off on charging, and the rapid dissipation of the charge on standing, are such serious faults that taken together with their low efficiency, the type is one of scientific interest rather than practical utility.

ARMATURE WINDINGS AND CONNECTIONS.

WENSTRÖM WINDINGS.

BY PROF. ARTHUR L. RICE.

If it becomes desirable to wind a four-layer armature into a two-circuit machine, the connections must, as in all other cases, be those for a wave winding and must fulfill the equation for wave windings:

Active conductors + No. circuits = No. poles x average pitch. If this equation be considered with reference to a four-pole machine with two-circuit winding, it becomes

Conductors + 2 = 4 x pitch,

which is impossible of fulfillment, if the number of conductors is to be divisible by 4, as would have to be the case in a four-layer machine; because, if to 4 x pitch—a number necessarily divisible by 4—2 be added, the sum cannot be divisible by 4. Some special device must be used when such a winding is wanted.

In a lap winding the only condition is that the number of conductors shall be divisible by twice the number of circuits. But a lap winding cannot be a two-circuit winding for any but a two-pole machine, therefore a combination of lap and wave windings must be used. This style has been called the Wenström winding; it follows no expressible law, but must be worked out for each case by study of the conditions, and the correctness proven by the winding table.

Take the case of the last article, four poles, 24 slots and commutator bars, 96 conductors; to be wound into a two-circuit armature. The winding is to be partly lap, partly wave; the wave part being in the connection to the commutator. The lap part amounts to the winding of several interposed conductors into a coil between those conductors which go to the commutator. Since the connection to commutator is in wave form, the number of conductors and bars used in making these connections must fulfill the wave winding equation. If there are twenty-four bars, there must be forty-eight conductors connecting to them, two conductors to a bar. Then 48 + 2 = 4 x pitch; 50 = 4 x pitch; or, 48 — 2 = 4 x pitch, 46 = 4 x pitch, and in neither case is the pitch a whole number. If one bar be unused, leaving 23 bars and 46 conductors, then 46 + 2 = 4 x pitch; 48 = 4 x pitch, pitch = 12; or 46 — 2 = 4 x pitch, 44 = 4 x pitch, pitch = 11. Therefore, twenty-three active bars and forty-six connecting conductors will be used. There will be 96 — 46 = 50 conductors left to be divided among the twenty-three active coils corresponding to the twenty-three active bars; 23 will go in 50 twice and 4 over, so that four conductors must be left dead and two intermediate conductors wound into each coil by the lap winding. The pitch to be used can only be determined by inspection, remembering that one conductor from each layer should be wound into a coil and that the lap connections should span about 90 degs. Four conductors which would wind into a coil must be left dead and one bar short-circuited to its neighbor.

Beginning at conductor 1, in the outermost layer, Fig. 1, the connection is taken to a conductor in the next layer at 90 degs. ahead, i. e., 22; from there to conductor 3, 90 degs. behind in the next layer, and thence to 24 in the innermost layer. Conductors 22 and 3 have been wound up by lap connection as the intermediate conductors of the coil; 24 must be joined by a wave-connected lead to the outermost conductor in a slot about 90 degs. ahead. If the slot exactly 90 degs. ahead is selected, the connection will be to 49, 70, 51, 72 in that coil, and then by a wave connection to 5, thus giving a progressive winding. If 45 is selected for the connection from 24 the course will be 45, 66, 47, 68 and then to 89, etc., giving a retrograde winding. The only advantage either way is that the retrograde has shorter leads. It has therefore been chosen.

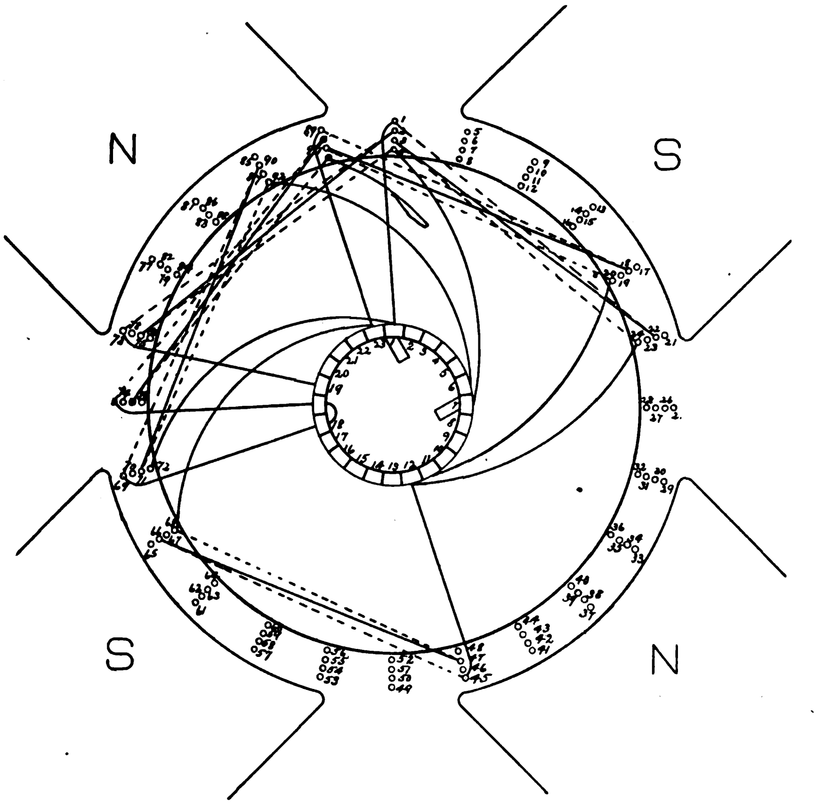


FIG. 1.—WENSTRÖM WINDING.

The connection gives eight conductors between a bar and the one adjacent; then between brushes, at 90 degs. apart, there will be 24 ÷ 4 = 6 bars, and 6 × 8 = 48 conductors, or about half those on the armature, so that it will be a two-circuit winding. The coil to be left dead has been taken as the one whose outer conductor would have been 73 if it had been used; the numbers are moved ahead in the same layer to the next slot, and all succeeding numbers in that layer must, of course be moved ahead one slot. For the second and fourth layers conductors 94 and 96 are the dead ones, so that their numbers simply disappear, as only 92 active conductors are to be used.

Only a part of the coils are shown to avoid confusion in the lines; the rest of the connection can better be followed from the winding table. The pitch from conductor 1 is 21 ahead to conductor 22; thence the pitch is 19 back to conductor 3; thence ahead 21 to conductor 24 and ahead to bar 12 which connects to conductor 45. The table will be:

	Bar	1	to	Conductor	1	to	Conductor	22
			“	“	3	“	“	24
to	“	12	“	“	45	“	“	66
			“	“	47	“	“	68
to	“	23	“	“	89	“	“	18
			“	“	91	“	“	20
to	“	11	“	“	41	“	“	62
			“	“	43	“	“	64 etc.

The table can easily be carried to completion by noting that, in the columns for bars, a number is always 11 ahead of the one just above (remember that the bar next after reaching 23 is No. 1); and, in the conductor columns, each number is 44 ahead of the one just above, remembering that after conductor 92 comes conductor 1.

MECHANICALLY STRONG INSULATORS.

The electrical artisan is woefully deficient in mechanically strong insulators. Porcelain and slate are brittle. Hard rubber deteriorates. Fibre absorbs moisture. Moulded insulators are not easily worked by machine tools, and mica is only valuable under compression strains. Inventors have been trying for several years, with the aid of ingenuity, hydraulic pressure and scrap material, to produce an insulator that will be generally adaptable. Such an insulator must be homogeneous and preserve its structure under high temperature or persistent moisture. It must possess a maximum of mechanical strength under all varieties of stress. If it is non-hygroscopic, its actual specific resistance need not be very high to make it a fortune to its compounder.

THE INDUCTION MOTOR.

IV. INDUCTION MOTOR ARMATURE WINDING.

BY ALFRED E. WIENER.

The winding of the induction motor armature, as stated before, consists in short-circuiting the rotor-conductors among themselves. In order to obtain the greatest possible effect in so doing, any armature-conductor must be connected to a conductor carrying a current of the same strength, but of opposite direction; that is to say, such conductors must be joined which include an angle equal to $\frac{180}{p}$ degs., if p is the number of pairs of magnet poles of the field.

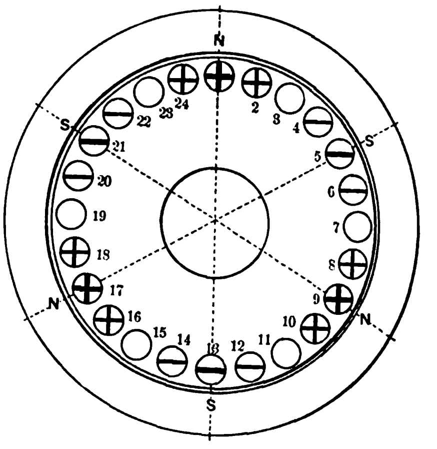


FIG. 1.—INDUCTION MOTOR WINDING, SHOWING STRENGTH AND POLARITY OF INDUCED CIRCUITS.

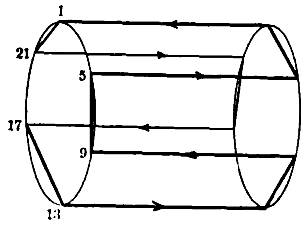


FIG. 2.—SERIES CONNECTION IN INDUCTION MOTOR ARMATURE.

In Fig. 1, an armature having 24 conductors is shown in a 6-pole field. The direction of the currents, which is the same for a 2- or a 3-phase motor provided that the field-polarity is the same in both cases, is distinguished by the + or — sign, respectively, and their relative strength is indicated by different thickness of the direction-signs. Accordingly, the conductors numbered 1, 5, 9, 13, 17, and 21, also conductors 2, 6, 10, 14, 18, and 22, etc., must be connected with each other. This can be effected in different ways.

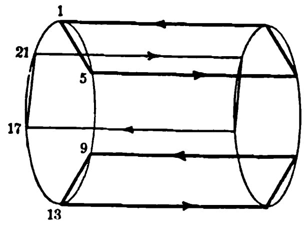


FIG. 3.—ADJACENT INDEPENDENT CIRCUIT CONNECTION.

(1). *Series-Connection.*—All the conductors of similar position with regard to the field-poles may be so connected with each other as to form one continuous closed circuit in which all the induced currents flow in the same direction, electrically, the conductors being placed in series to one another. Fig. 2 shows one group of equivalent conductors so connected in the form of a wave, 1—5—9—13—17—21, the complete winding for the case considered in Fig. 1 consisting of four separate circuits similar to the one illustrated.

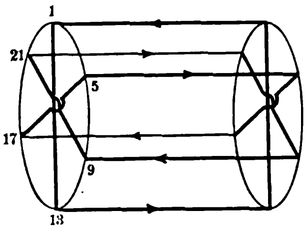


FIG. 4.—DIAMETRAL INDEPENDENT CONNECTION.

(2). *Independent Circuit Connection.*—A number of independent closed circuits may be formed, by joining each conductor with its similar in the adjacent space of opposite polarity, or else with the one diametrically opposite. Thus, in Fig. 3 three circuits, 1—5, 9—13, and 17—21, are formed when connecting each group of conductors in the manner first named. Connecting the conductors in the second fashion, the three independent circuits are 1—13, 5—17, and 9—21; see Fig. 4. In both cases the complete armature will have 4 × 3 = 12 separate circuits.

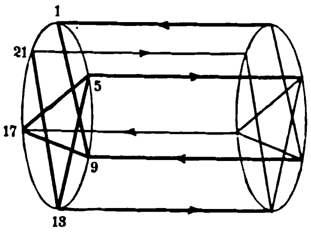


FIG. 5.—SERIES PARALLEL CONNECTION.

(3). *Series-Parallel Connection.*—All similar conductors of one polarity may be connected in parallel and joined in series with all similars of the opposite polarity, the latter being themselves grouped in parallel. In Fig. 5 the + conductors of the first group of similars, 1, 9, and 17, are accordingly put in multiple and placed in series with the parallel-connected — conductors, 5, 13 and 21, of the same group, the series-connection being effected by face-conductor 17—5. Four such circuits will complete the armature-winding in this case.

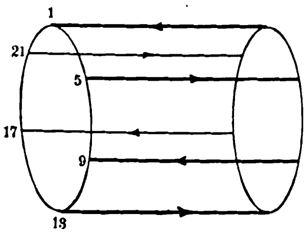


FIG. 6.—SQUIRREL CAGE CONNECTION.

(4). *Parallel Connection.*—All conductors on the armature may be joined in parallel, as shown in Fig. 6. For, when considering the independent circuit connection, Fig. 3, it is seen that it will be immaterial whether conductor 1 is paired with conductor 5 or with 21. Hence, in connecting conductor 1 both with 5 and with 21, conductor 9 with 5 and with 13, etc., the current from each conductor can be considered as flowing in divided circuit through two independent circuits, and thus a parallel grouping of all conductors is obtained which is electrically equivalent to the independent circuit winding. Similarly, the method of parallel connecting can be derived as a special case of the grouping depicted in Fig. 4. Here the e.m.fs. in the two halves of every closed circuit are equal, by virtue of the fact that only similar conductors are joined together; there is consequently not the slightest reason why the separate loops should not be connected at their crossing point, and again the short-circuited winding is arrived at. Finally, in Fig. 5 the series-connection, instead of being placed between conductors 17 and 5, may be divided among two pairs of conductors, or may even be distributed among all of them, thus— 1—5—9—13—17—21—1; but this is nothing else but the parallel connection illustrated in Fig. 6.

This parallel arrangement which, from its similarity in appearance with that familiar form, has received the name of the "squirrel-cage" winding, has the advantage over all the remaining methods of grouping that, since half the current from each conductor will flow into the next conductor on one side and half into the one on the other side, only one-half the cross-section is required for the connecting face-conductors. Besides this reduction in weight, the process of cross-connecting itself is by this method rendered extremely simple, mechanically, no complicated system of connecting and crossing of end-wires being required, but merely a pair of closed end-rings which are either inserted into slots provided in the ends of the conductors, or which are themselves supplied with sockets, or lugs, to receive the conductors.

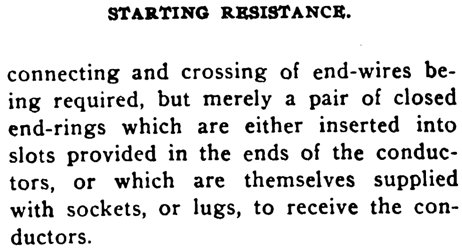


FIG. 7.—THREE-COIL WINDING OF INDUCTION MOTOR ARMATURE, SHOWING STARTING RESISTANCE.

Open Circuit Armature Winding.—In large induction-motors, for the double purpose of avoiding too great a current-rush when switching the motor into circuit and of obtaining a larger initial turning-force, or torque, it is necessary to insert starting-resistance into the armature-circuit. This is usually effected by connecting the armature conductors into three parallel circuits, one end of each of which is led to a common junction while each free end is connected to a collector-ring on the shaft. Each of these rings leads off, by means of a contact-brush, to an adjustable resistance, the three resistances being equal to each other and so connected to a starting switch that by its manipulation corresponding equal portions of the three resistances are in turn grouped in parallel, the switch-lever then forming a second common junction. Since for this arrangement it is necessary that the number of conductors per pole is a multiple of 3, in the adjoined diagram, Fig. 7, the connections are shown for a 12-conductor armature supposed to be acted upon by a 4-pole field.

If the number of conductors is simply a multiple of 3 without being divisible by the number of poles, a grouping into three circuits is possible, to be sure, but the currents in the three branches all flow either toward or from the common junction, so that a fourth collector-ring would be required to establish connection between the two common junctions. The same holds true in case of two parallel branches for any number of armature-conductors, hence the smallest number of collector-rings for any grouping into open parallel circuits is 3; and as the direction of the currents in the armature-conductors depends only upon the number of poles in the magnet-frame but not on the number of phases supplying the field-winding, it follows that the 3-coil winding shown diagrammatically in Fig. 7 will answer equally well for two-phase as for three-phase motors.

◆

A CONVENIENT RULE FOR THE CALCULATION OF THREE-PHASE CIRCUITS.

One of the most popular circuits in multiphase transmission is the three-phase, three-wire system. The calculation of the proper sizes of wire for a power transmission upon this system has frequently bothered devotees of direct current. In attempting its solution they very shortly are tangled up with the square root of three, which has unaccountably incorporated itself into their calculations, and they are also likely to calculate the three drops, one on each wire, and are then in a quandary as to whether these should be added, averaged, or the third neglected. A simple and satisfactory rule is the following:

The ratio of the amounts of copper used for equal power, drop and voltage is 100 for the single-phase and 75 for the three-phase system. The single-phase system, as is well known, is calculated by ordinary direct current rules and uses two wires. The three-phase system uses three wires. It then follows that, if we calculate the proper size of wire by ordinary direct current rules, and then divide the circular millage of that wire by 2, we shall have the proper size of wire for a three-phase circuit, because 75 per cent of the volume of two wires of a given size is equal to the volume of three wires of half that size, lengths being equal.

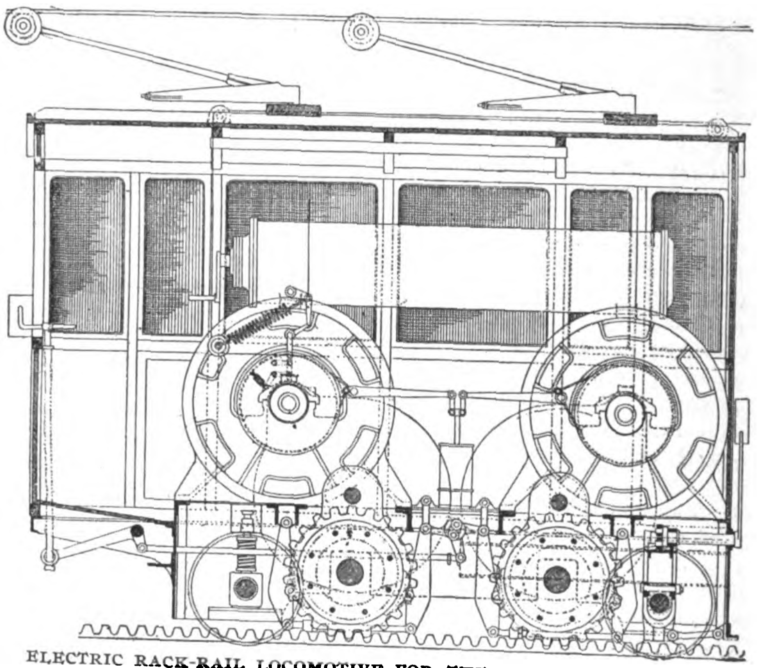
Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Electrolytic Manufacture of Hydrogen and Oxygen.—"L'Eclairage Electrique" describes an installation for the electrolytic manufacture of oxygen and hydrogen recently erected by the Société l'Oxyhydrique at Brussels. The electrolyzers consist of very narrow cells of steel plate, having perforated walls. These are put together with a copper solder. In each cell is an electrode of steel plate. Although not so stated, it is inferred that these are immersed in a tank of the electrolyte, which consists of a solution of soda kept at a temperature of 104 degs. F. The voltage at the terminals of a cell is 2.5 and the current density about 35 amps. per sq. ft. Under these conditions a k.w. hour produces 2.87 cu. ft. of oxygen and 5.75 cu. ft. of hydrogen. Of course, the commercial value of the process depends entirely upon the cost of electric power in the neighborhood of the plant. The gases obtained are very pure, the oxygen being 97 and the hydrogen 99 per per cent pure, the impurity in each case consisting of the other gas. By passing the gas through a red-hot tube these impurities unite with it to form water, which may be easily dried out, leaving the pure gas.

Electricity on the Jungfrau.—In the progress of the work on the electric railway to the summit of the Jungfrau electricity is playing a prominent part. According to an article in "Prometheus" (Berlin) the boring of the tunnel, of which the greater part of the line is composed, is proceeding by the use of electric drills of the revolving variety. There are five of these in use, each being mounted on a vertical beam wedged between the floor and roof of the gallery and operated by a 3-h.p. motor on the rear side of the beam. The boring points are made of crucible steel, toothed, but without diamond points, and each has a channel through which water is pumped (by an electrically driven pump) to wash out the boring dust. One of these outfits will bore a hole 1¾ ins. diameter and 40 ins. deep in the hard rock of the heading in 12 to 15 minutes, with a current consumption of 7 amps. at 220 volts. When each machine has bored four holes they are all taken down and the twenty holes are fired, explosive gelatine being used. This substance freezes at 4 deg. C., and then becomes very sensitive to shocks and exceedingly dangerous. Accordingly, an electric heater is provided for its storage at a proper temperature. Another use to which the electric heating apparatus has been put is melting the ice of the Eiger glacier to supply the boring machines with water for washing out the holes. This was during the past winter, when all the water in the neighborhood of the workings was frozen. It is stated that for each yard the tunnel progresses 1 cu. yd. of water has to be provided for this purpose.

Electric blowers are used to ventilate the tunnel, zinc tubes 1 ft. in diameter taking the fresh air close to the headings. At the workmen's headquarters near the month of the tunnel are buildings for offices, shops and dwellings, as well as a hospital, canteen, etc., and these are all electrically heated as well as lighted. The winter climate of the high Alps is very severe, the dwelling houses being lined with wood, then a layer of felt, a layer of air, and another ceiling of wood inside the stone walls. All lighting, heating and cooking in this village is by means of electricity.



ELECTRIC RACK-RAIL LOCOMOTIVE FOR THE JUNGFRAU RAILWAY.

The locomotives for this railway are of the rack pattern, as shown in the illustration. Each has two motors, of 150 h.p. each, running at 800 r.p.m., geared to the two sprocket wheels. The locomotive weighs thirteen tons and is intended to haul two cars, each seating forty passengers.

On the top of the Jungfrau it is proposed to place searchlights of great power to light up the neighboring peaks at night. There is also to be a hall hollowed out of the rock of the summit for the accommodation of visitors in stormy weather and this is to be, like the rest of the stations of this most remarkable railway, lighted and heated by electricity.

Improvements in Recording Pyrometers.—Mr. A. Stansfield describes in the "Philosophical Magazine" a new recording pyrometer, which promises to be useful in a number of investigations. He uses a thermo-electric couple of platinum and a platinum-rhodium alloy, fused together at the end and protected by a thin fire-clay tube. Insulation is effected by a slip of mica between the wires of the couple. If such an instrument is used at high temperatures the curve of records, if on a scale sufficient to show minor variations, must be at a considerable distance from the zero line. To obviate this difficulty Mr. Stansfield balances out the major part of the potential generated, leaving the minor fluctuations to affect a sensitive reflecting galvanometer. In front of this is mounted a photographic plate in a carrier, which is mounted on a float in a cylindrical vessel arranged to rise gradually as water is admitted to it. The light from a convenient source is allowed to fall upon the plate, and the combination of the motions of the plate and the spot of light give an autographic record of the temperature differences during the experiment.

Wireless Telegraphy.—The "Electrician" says: "One of the varied applications of wireless telegraphy received an interesting illustration at the Kingstown regatta, last week, when Mr. Marconi demonstrated the adaptability of his system to the transmission of press intelligence from a steam launch in motion. The yachting expert on deck dictated his account of the races while these were in progress, and a stream of dictated 'copy' descended below deck to Mr. Marconi, who sat in a cabin working his transmitter, whence the ether waves carried the news with a minimum loss of time to the receiving station on shore. Arrived at this point, the news was forwarded on to the press offices by telephone. It is stated that one edition of an evening paper contained two whole columns of news dispatched entirely by wireless telegraphy. This notable event is undoubtedly the germ of an important development of wireless telegraphy in the near future."

Searchlights on Captive Balloons.—The Russian War Department, says "Industries and Iron," is conducting a series of experiments on searchlights mounted in captive balloons, the current being supplied through the cable that secures the balloon. Searchlights up to 5000 c.p. have been used and these, when at an altitude of 1800 ft., illuminate a circular area of 1500 ft. diameter. It is not stated what this sort of light is to be used for, but recent experience with war balloons leads one to think that such an arrangement would be much more dangerous than useful in the presence of an enemy who has the use of his eyesight.

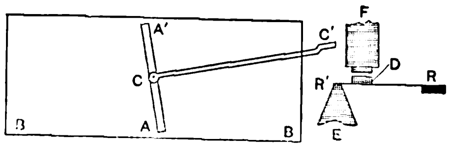
A New Electrical Thermometer.—An ingenious adaptation of the principle of the Bruger ohmmeter has been applied by a German firm to the construction of pyrometers or electrical thermometers, says "Industries and Iron." Two crossed coils are free to rotate in a strong non-homogeneous magnetic field. In circuit with one of them is a resistance of fixed value, and in circuit with the other is the resistance to be measured, in this case the temperature wire. The scale of the instrument is graduated to read directly in degrees. The apparatus can be made for any range of temperature, and by altering the shape of the pole pieces it is possible to produce an open scale in the neighborhood of any desired temperature. For high temperature work a platinum wire is used, a nickeline wire being utilized for moderate temperatures. Temperatures up to 1200 degs. C. (2200 degs. F.) can be measured with the instrument, and it is said to also work satisfactorily at very low temperatures. The current required is about 0.03 ampere at 5 volts, and the instrument may be left in circuit indefinitely without injury.

Electric Furnaces.—The (London) "Electrical Engineer" gives an abstract of the paper presented by MM. Gin and Leleux to the Académie des Sciences on electric furnaces. The fall of potential of an arc striking across a given medium they regard simply as due to the resistance of the mass of gas lying between the electrodes. If this mass of gas is regarded as a cylinder with a sectional area equal to that of the electrodes, and if this cylinder is assumed to be surrounded by a perfect thermal screen it can be shown that the temperature of the arc would increase as the square of the current and the ratio of the resistivity of the gas to its specific heat per unit volume, the latter factors being themselves variable with the temperature. When the arc is allowed to pass through a mixture such as that used in making calcium carbide the arc forms a sort of pocket around itself, at the upper pole of which is a crater through which various gases and vapors escape. The volume of this cavity increases up to the point at which the heat liberated by the arc is in equilibrium with the losses of heat to the surrounding medium. After cooling it is found that the interior of the pocket is lined with a brilliant layer of graphite, outside of which is a concentric layer of carbide in crystals, and behind this a layer of unaltered material. The result can be explained by assuming either that the carbide dissociates at the temperature of the arc or that the calcium oxide volatilizes so fast that part of it is lost and remains unreduced. Direct experiment shows that calcium carbide is dissociated at a temperature below that at which carbon volatilizes. The tension of the arc varies with the nature of the surrounding atmosphere. For example, with calcium carbide mixture, when the stationary temperature is reached the tension is from 18 to 20 volts, the electrodes being 4 ins. apart, while with a mixture of carbon and manganese oxide the tension is only 10 volts and the pocket formed considerably larger.

Expansible Enamels for Electric Heaters.—In most forms of electric heating apparatus or resistance coils, where the wire carrying the currrent is imbedded in a mass of enamel, difficulty is encountered by the different rates of expansion of the wire and the enamel, causing them to split apart, admitting air to the interior and oxidizing the metal and making the apparatus dangerous from the underwriters' point of view. "L'Elettricitá" contains a short note of the work of M. Damour recently presented to the Société d'Encouragement pour l'Industrie Nationale. His researches were undertaken to find a market for one of the by-products of the "Société du Biborax," natural borate of calcium, or pandermite. The method of finding the enamel with the highest coefficient of dilation was as follows: A number of mixtures of pandermite and one other substance were made and tested for dilation. Of these the best were selected and each in turn mixed with a third substance. This process of trial and exclusion was followed through many steps and excellent results obtained. Among the best mixtures are the following: Mixture A: 50 parts Fontainbleau sand, 18 parts pandermite, 23 parts carbonate of lime, 35 parts carbonate of soda. Coefficient of dilation: 0.00001012. A mixture of 9 parts of mixture A and 1 part of rutile (titanium oxide) has a coefficient of 0.00001016. Ninety parts of A, 5 of magnesia and 5 of cryolite give a coefficient of 0.00001019. A mixture of 9 parts of A and one part of bicalcic phosphate increases the coefficient to 0.00001058. A still simpler mixture, consisting of 30 parts of pandermite, 20 of cryolite and 50 of feldspar has a coefficient of 0.00001055. As the coefficients of expansion of platinum, iron and nickel fall within the limits of the figures above, these metals may be used in connection with the new enamels with great satisfaction.

A Direct Acting Quantity Meter.—M. R. Blondlot recently presented to the Académie des Sciences a description of a very ingenious quantity meter which is based on a principle that seems to lend itself readily to practical application. A long hollow coil is set up so that its axis is horizontal. In the center of this coil a second coil in the shape of a ring is suspended so that it is free to oscillate around a vertical axis, its plane being vertical. The current to be measured is led through the two coils in series, mercury cups being used to connect the stationary and movable parts. Now if terrestrial magnetism is compensated the movable coil takes a position of equilibrium under the action of the current, with its spires parallel to those of the stationary coil. If the movable coil is displaced it will make a number of isochronous oscillations around this position of equilibrium. The period of swing, T, is inversely proportional to the square root of the moment of the couple exerted by the two coils. This moment is proportional to the square of the current intensity, i, so that the product, iT, is evidently a constant. Hence the proposition that the same quantity of electricity always passes during the period of one free oscillation.

The apparatus for practical use is arranged as shown in plan by the illustration. A A′ is the movable coil, carrying the index C C′. The oscillations are confined to one side of the position of equilibrium. R R′ is a light spring, fixed at one extremity. When the index swings to its middle position it establishes a contact with the end of the spring R, closing the circuit of the electromagnet e, and thus giving the movable part of the apparatus a "kick" which keeps it swinging. Of course, if there is no current the apparatus will stop. All that is necessary to use this apparatus for current measurement is to find its constant, or the amount of electricity passed at each oscillation, and count the impulses given by the magnet e. This is done in practice by a counter moved by the magnet itself, so that there is no mechanical connection between the oscillating coil and the counting apparatus. The instrument is said to be sensitive and satisfactory and it certainly seems to be capable of development.



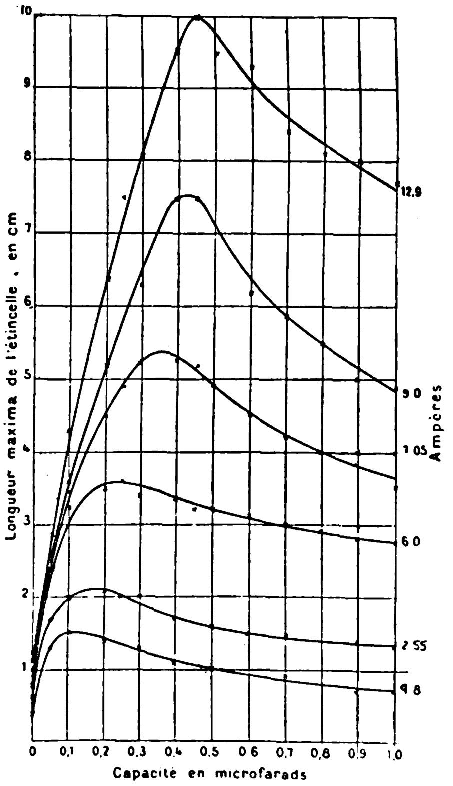
PLAN OF OSCILLATING QUANTITY METER.

Electricity in the Philippines.—According to a note in "Industries and Iron" there are about 720 miles of telegraphs in the Philippine Islands and about seventy miles of steam railway. There is no electric railway. The city of Manila has a telephone exchange, overhead lines with porcelain insulators being used. The electric light station at Manila supplies current to about 12,000 incandescent lamps and 260 arc lamps. The installation was made by an English firm having headquarters at Yokohama.

Electro-Deposition of Platinum.—In the "Electrical Review" (London), Mr. Sherard Cowper-Coles gives a number of formulæ for solutions to be used in electro-plating platinum. Among the most modern that he mentions are Boettger's solution, which consists of the double chloride of platinum and ammonia dissolved in water to which a few drops of liquid ammonia has been added. The solution is worked warm. Another solution due to Boettger consists of the double chloride of ammonia dissolved in 8 parts of sal ammoniac mixed with another of the double chloride of platinum and ammonia, freshly precipitated at a boiling temperature, dissolved in a concentrated solution of neutral citrate of sodium. The resulting liquid is a deep orange color with a feeble acid reaction. It should be worked cold with a current density of about 3 amps. per sq. ft., and an e.m.f. at the terminals of 7.5 volts. If the solution contains about 1½ ounces of platinum to the gallon excellent bright deposits are obtained. Gore gives a solution of chloride of platinum dissolved in a solution of potassium cyanide, the proportions of metal being about 1 oz. to the gallon and the bath being used warm. Jewreinoff states that the platinum anode is freely dissolved in a solution made by dissolving 10 parts of metallic platinum which has been converted into the chloride in 10 parts of caustic potash in water, the yellow precipitate being dissolved by the addition of 20 parts of oxalic acid in solution and the application of heat. To this solution is added 30 parts of caustic potash solution. The bath is, of course, strongly alkaline. Another bath recommended by the same author, in which he also uses platinum electrodes, consists of 3 parts of platinum converted into chloride and dissolved in 300 parts of water, to which is added 25 per cent. of sulphuric acid.

Wind as Motive Power.—An interesting paper by Prof. La Cour, a well known Danish scientist, on the above subject is abstracted in "Engineering." The history of the utilization of natural powers is of great antiquity. The first technical paper on the subject emanated from Hero of Alexandria about 2000 years ago, but though the subject was widely discussed and commented upon it seems to have lain in abeyance for about 1500 years, when a new move was made by various Mahometan scientists and the movement culminating in the invention of the steam engine was inaugurated. To this day the problems connected with wind-mills have not all been solved. While it is recognized that the shape of the vanes should be portions of curved surfaces, the best and most efficient curves have not yet been calculated. Much of the earlier mathematical work on this subject was fallacious because founded on incorrect physical assumptions as to the action of the wind on the vanes. The "suction" on the lee side of the vane is now known to be an important factor in the action. At present the most important practical point in connection with such machinery is how best to neutralize the inconvenience caused by the irregularity of the wind and thus adapt wind-mills to dynamo driving.

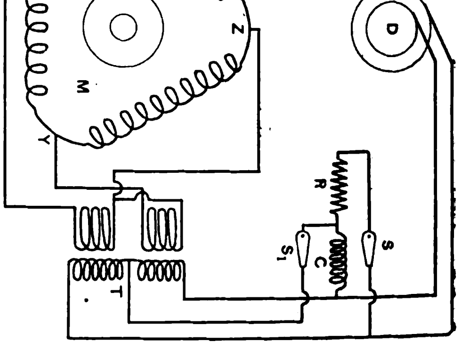
Condensers for Induction Coils.—The length of the secondary spark of an induction coil is considerably increased by the use of a condenser in the primary circuit, but the exact part played by this condenser is not definitely understood. The most general opinion is that the extra current of the primary circuit charges the condenser, instead of expending itself in sparking at the interrupter, and by more quickly causing the dying out of the primary current increases the e.m.f. in the secondary. This explanation seems insufficient, and a Japanese scientist, Mr. Tulbizuno, has made some researches upon the effect produced by the variation of the capacity of the condenser shunted around the interrupter, of which an account is given in "L'Industrie Electrique." He used a coil 4½ ins. in diameter and 8 ins. long, fed by a battery of nine secondary cells, and a condenser having a capacity varying from 0.05 to 1 microfarad. The sparks were discharged between a point and a plate, both carefully cleaned after every spark. The results obtained are plotted in the accompanying curve, where the current intensities in the primary are given in amps., and the spark lengths plotted as ordinates and the capacities as abscissæ. The curves distinctly show that for a given current intensity there is a definite value for the capacity giving the longest spark.



CURVES OF SPARK LENGTH, CAPACITY AND PRIMARY CURRENT.

Electric Light in Cotton Mills.—The "Mechanical World," in a leading article, says that the inclosed arc lamp nearly approaches the ideal of perfection for the lighting of cotton mills. In these mills and in many other establishments where textile industries are carried on it is necessary that the light shall not falsify colors, and at the same time that it shall be evenly distributed, and not especially dangerous from the fire underwriters' point of view. The inclosed arc possesses all these advantages, and, in addition, is cleanly, and not apt to give off any smoke or dust injurious to the fabrics, while with long-burning lamps it is not necessary to trim oftener than two or three times a year when ordinary working hours are observed.

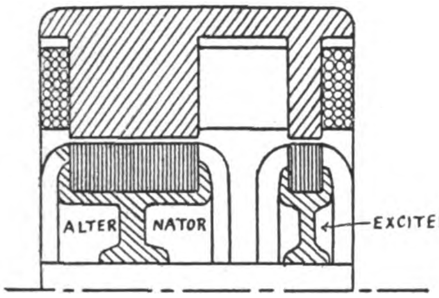
Phase Transformers.—The usefulness of some simple form of phase transformer enabling single-phase currents to be split up into polyphase currents and thus permitting the use of a simple conducting system of one wire would be especially appreciated in the field of railway work, where any attempt to use polyphase currents for power purposes is met at the outset with the difficulty of a double trolley system. In a very valuable paper, in "Zeitschrift für Elektrotechnik," Herr Gustav W. Meyer discusses all the forms of phase transformers with special reference to this application. An ingenious device for operating a three-phase motor on a single-phase current supply is illustrated. The motor, M, has the usual field winding and a three-phase winding on its rotor. The stator is connected as shown to the two ends and the middle point of the secondary of an ordinary split transformer, and in the primary circuit with this is connected a non-inductive resistance, R, and a self-induction coil, C, as shown. By the switches S and S_1, these can be cut in or out of the circuit. At starting they are cut in, as shown, and produce a sufficient displacement of phase to start the motor. After the motor attains speed the switches are opened and the reaction of the three-phase winding on the rotor induces a current in the part XY of the stator winding, the machine continuing to run as a three-phase motor, though supplied with single-phase current. It is claimed that this method surpasses the rotary phase transformer of Arnó and Ferraris on account of its simplicity and cheapness and absence of moving parts.



STATIONARY PHASE TRANSFORMER.

Self-Regulating Alternator.—An extremely ingenious method for the compounding of an alternator without the necessity of rectifying the current for this purpose is described by E. Danielson in

"Elektrotechnische Rundschau," an abstract appearing in "Science Abstracts." The exciter armature is mounted on the main shaft and the same field winding serves for both alternator and exciter, the latter being series-wound. On the armature of the exciter is wound the compounding coil, which is supplied with an alternating current, either the main current of the machine or a transformed current being used. This winding is so arranged with respect to the generating winding of the exciter armature that the currents in the two oppose each other, and is so proportioned that when the main alternating current is in phase with the e.m.f. the exciter armature reaction strengthens the field sufficiently to make up for the drop due to resistance and inductance in the alternator armature. If the main alternating current lags behind the e.m.f. the armature reaction of the exciter will be increased so as to strengthen the field, and so the exciting current and field of the alternator, so that the effective voltage across the terminals of the latter is maintained constant. The method compensates automatically, not only for the ordinary drop due to self-induction and resistance, but for armature reaction due to phase displacement as well. It is equally adapted to polyphase and single-phase machines.



SELF-REGULATING ALTERNATOR.

A machine of this type will doubtless regulate very well if the speed is maintained absolutely constant, but it is evident that it is doubly sensitive to irregularities in speed of driving.

Broken Trolley Wire Cut-Out.—In a letter to "Elektrotechnische Zeitschrift" G. B. Folco describes a system for cutting out broken trolley wires which have fallen and not made a good enough earth contact to work the magnetic cut-outs at the central station. He replaces the usual section switches with his apparatus, which are a variety of magnetic cut-outs, having their coils in a special circuit, as shown in the diagram. If now a break occurs, say, in the section m_1m_2, the current passing through the switch apparatus a_1 to the further sections of the line would be diverted through the coil of the magnetic cut-out and open the line at m_1. This system requires that there should be cars in operation beyond the point of the break, so that it is inoperative for the terminal section; but the author points out that the terminal section may be made as short as desired, so that the system seems a very simple and satisfactory one.

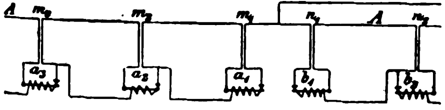
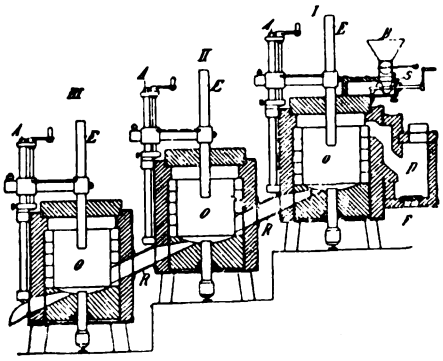


DIAGRAM OF TROLLEY WIRE CUT-OUT.

Regenerative Electric Furnaces.—A system of regenerative electric furnaces is described in "Zeitschrift für Elektrochemie," from which the accompanying illustration is taken. Three or more furnaces are arranged as shown, the material to be operated upon being first introduced into the upper furnace through the hopper H. Gaseous products escape by the flue at the right, depositing dust in suspension in the dust-chamber D, from which it may be removed through the hand-hole F. The melted products flow down through the tube R into the second furnace, parting there with some of their heat. When the second oven is thus sufficiently warmed, it is put in operation, and similarly the melted products from each furnace flowing through those below heat them and thus utilize an otherwise wasted amount of energy. It is claimed that a furnace system of this type has shown an economy of over 20 per cent greater than that exhibited by the ordinary detached furnace. It is not stated in the article to what variety of electric furnace work this system is especially adapted, but its use is evidently restrained to those processes in which there is a liquid product.



REGENERATIVE ELECTRIC FURNACES.

Ozone.—Mr. John B. C. Kershaw writes in the (London) "Electrical Review" a résumé of the methods for the commercial production of ozone, and compares the cost of this oxidizing agent with that of others. The methods of producing ozone are as follows:

Andreoli's Method.—This uses plain aluminum electrodes, made by covering wooden boards of the size required with aluminum foil, while the "grid" electrodes are made by stretching serrated aluminum wires across an appropriate wooden frame. The two electrodes and a sheet of glass acting as a dielectric are clamped together in a wooden frame, and any number of these units can be built up to form an ozonizer of the desired capacity. Alternating currents of high voltage are used for working these instruments, the ½-k.w. unit taking 0.13 amps. at 2800 volts. This form of ozonizer is said to yield 125 grams (4.37 ozs.) of ozone per k.w.-hour. Otto's ozonizer is made of a thin sheet of metal laid upon a sheet of glass or fixed between two glass plates. The air enters at one end and passes in a zigzag manner between the several elements forming the ozonizer. Otto's chief discovery is that the "output of ozone is proportional to the periodicity of the alternating current used." He states that the output is a maximum when a periodicity of eighty per second is used, and claims a yield of 155 grams of ozone per electrical h.p.-hour. The Yarnold ozonizer consists of a flat-shaped box containing a number of glass plates coated on one side with gold leaf. These metallic films are connected alternately in parallel with the two sides of the supply circuit. The air is passed into the spaces between neighboring plates, and does not come into contact with the metallic films. A yield of 175 grams per electrical h.p.-hour is claimed. The Siemens & Halske ozonizer consists of an arrangement of tubes, each unit consisting of an inner metal tube and an outer glass tube covered with tin-foil on its external surface. Water flows through the inner tubes to keep down the temperature, while air is circulated through the annular spaces between the tubes. Its output is stated to be 20 grams per electrical h.p. hour, and the machine has been in use in Germany for about fourteen years.

Among the numerous uses that have been suggested for ozone or ozonized air produced by these apparatus may be mentioned: Aging wood for musical instruments, maturing wines and spirits, sweetening foul beer casks, drying and thickening oils, bleaching waxes and fats, seasoning linoleum, bleaching fabrics and yarns, sterilizing drinking water and producing vanillin and similar organic bodies. While a number of these processes are dependent upon ozone there are many cases where other oxidizing agents can be used, and it is necessary to compare the cost of the various processes of oxidation. The author gives the following table of the comparative costs of producing 1 kilogram (2.2 lbs.) of active oxygen, electrical energy being assumed to cost 3 cents per electrical h.p. hour, which is the least that can be expected considering the small quantities used:

Source.	Cost in cents.
Bleaching powder	36.6
Sodium bichromate	96.0
Ozone (Yarnold's ozonizer)	123.0
" (Otto's ozonizer)	132.0
" (Andreoli's ozonizer)	167.4
Sodium manganate, acid solution	172.0
" " alkaline solution	306.0
Ozone (Siemens and Halske ozonizer)	522.0

These figures show bleaching powder to be the cheapest oxidizing agent, where the use of this form of chlorine gives satisfactory results. There are many applications, however, in which ozone finds ready and legitimate use, and it is to be expected that its use in the manufacture of oils, fats and organic chemicals will rapidly extend.

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Mr. W. D. Weaver, editor of the "American Electrician," who has been temporarily absent, is expected home during the next few weeks. At the opening of hostilities with Spain Mr. Weaver was commissioned chief engineer of the U. S. S. "Glacier," which is now in West Indian waters. Mr. Weaver is a graduate of the Naval Academy of Annapolis, and after having made a most honorable record in the Navy, resigned some years ago to enter the field of electrical journalism.

Electrolytic Action on the Brooklyn Bridge.

A recent accident on the bridge, which resulted in the buckling of several of the girders, has been the subject of numerous scare heads in the daily papers and mysterious illusions to the deadly current that is supposed to be continually gnawing at the foundations of the bridge.

There is, without question, a considerable current flow in the cables of the bridge. This is evidenced in numerous ways. A compass needle placed over the cable will deflect at right angles thereto, and frequently flashing arcs are noticed between the traction cables and the pulleys on the the traction cables and the pulleys at the termini.

The current has been thought to have its origin at the foot of Fulton Street, where there is heavy traffic and frequently congestion of traffic. From this point the current that is fed into the ground must reach the Kent Avenue power house by a somewhat circuitous route around Wallabout Bay. A portion is supposed to enter the bridge at the Brooklyn anchorage and traverses the cables, for the most part, across the river to the New York end. It thence proceeds up the East River shore and across the river above Wallabout Bay to the station. Experiments with the compass needle, however, show that the current is frequently travelling toward Brooklyn, and therefore that the traffic at the New York end has raised that locality above the Fulton Street potential. Particularly is this the case when the bridge trains are operated entirely by electricity. Wherever the current leaves the bridge structure is the point to be watched.

The cable anchorages, set, as they are, in masonry and concrete, seem to afford a rather poor exit for the current, for it is inclined to follow the traction cables into the termini. Important matters like this, however, should not be decided on speculation; it should be definitely determined just how much current enters the cables and where it is leaving them.

It ought not to be a difficult matter to provide some immense copper clamps to grasp the cables just before they enter the anchorages and securely ground them, in this way deflecting the current from the anchorage proper, and, comparatively speaking, it should be an inexpensive undertaking.

The Future Street Railway Motor.

Each succeeding year there is developed a new street railway motor, lighter, more convenient, cleanly and powerful, and easier to maintain and repair. It is generally admitted that we have by no means seen the end of these improvements. The steam locomotive of to-day has become very nearly a standard product; the improvements made upon it are of a minor character; and we must expect within a few years to see the railway motor in such a condition. Apropos of this convention season it is, perhaps, in order to speculate as to what form this finished railway motor will take.

The 500-volt devotees have much to apprehend from the alternate current system. The three-phase systems at Lugano, the Gorner-Grat and the Jungfrau have met with success in sufficient measure to warrant further experiment and installation. The long distance suburban railway traffic is increasing, and with it comes a great demand for an economic distribution of electric power, and the engineer naturally turns to alternate currents. The induction motor has been practically perfected for stationary work. It is commutatorless and some types dispense with brushes. Its moving wire circulates currents of low voltage only. It is capable of being built and is, in fact, inherently built on ironclad lines. It is light in proportion to its output and is otherwise a thoroughly desirable railway motor. In fact there is only one objection that is offered by electric railway engineers, namely, the uneconomical control at variable speeds. In this it must be admitted that the direct-current motor has the advantage.

We must remember, however, that there is something besides motor efficiency to be considered in an electric railway system. The cable system has only one economical speed, and it has for many years been a commercial success and only very recently is it being displaced. The induction motor, on the other hand, can easily have two economical speeds, by means of subdividing the pole pieces and controlling on the intermediate notches by means of resistances, and modern engineering is rapidly bringing the control of the induction motor on these lines to an economy approaching that of the direct-current motor. Inasmuch as in other respects the induction motor is immeasurably superior to the direct-current motor, it is evident that the former must soon receive a trial. It may further be noticed that on interurban service the speed of the motor is not continually changing; top speed or half speed are usually employed; in fact, the motorman is directed not to run his car on any but the series or parallel positions, except on starting and stopping. In such service as this the control of the direct-current motor is no better than that of the induction motor.

The conclusion seems to be that the introduction of the induction motor is delayed, not by want of electric improvement, but by prejudice. Soon some daring investor or engineer will install an interurban induction motor system in this country, and that day will mark a revolution in American electric railway practice, if the reports we hear from both at home and abroad are to be believed.

The conduit systems now in use with two underground conductors are easily adaptable to the use of multiphase circuits by using the ground as an additional return. Of course, in overhead work the system will be considerably hampered on account of the double trolley. The double trolley, however, is a practical device, as direct current work has demonstrated in many instances, and engineers will not hesitate at its adoption, if greater advantages can thereby be obtained.

Straight Teeth Versus T Teeth.

Within the last year or two there has been considerable discussion as to the relative merits of straight and T-shaped teeth in armature construction. Both unquestionably have their advantages. The T-shaped tooth claims among other features the great advantage of securing the coils singly and securely without the aid of band wires by means of a wooden filler in the top of the slot. Further than that, the heating of the pole piece due to eddy currents is very much less marked with T-shaped teeth than with straight teeth. In a toothed armature the flux of force goes almost entirely through the teeth and during the revolutions of the armature the teeth carry each a tuft of lines of force after the manner of a paint brush, subjecting the surfaces of the pole piece to rapidly varying densities of magnetization, thereby producing intense eddy currents. It is evident at once that with the T-shaped tooth the slot is narrower and the rate of change of magnetization due to this cause is very much less. However, modern dynamo design is using laminated pole pieces, both to eliminate these eddy currents and to reduce the section of field magnet waist, by the use of soft wrought iron plates, and in such a construction the advantage of T-shaped tooth disappears. Moreover, a bobbin or coil wound in a slot with overlapping teeth is more highly self-inductive and therefore will not commutate as well in regions in advance of or preceding the true neutral line. Further than this, an armature with T-shaped teeth is harder to wind; the slots are more inaccessible; and, if the overlapping of the teeth is very great, the conductors will have to be forced in from the ends of the slots, after the fashion of tunnel winding.

Considering straight teeth, it seems that the only objections that can be urged against them is the heating which they cause in the pole pieces and the necessity of band wires. A laminated pole has practically eliminated the first of these difficulties, and as it is being adopted for various reasons it cannot be said to be forced upon the designer on account of the use of straight teeth. The band wires are certainly a disadvantage, although it is urged by their users that they contribute greatly to the ease of the repair of the armature, and that the removal of a few bands frees all of the coils. Unfortunately, however, it is almost always necessary to place these bands in the clearance, where they will be subject to the action of eddy currents; and any attempt to secure them by means of transversely soldered joints creates a spot for eddy currents, which may be generated in sufficient magnitude to melt the joint apart. The frequent failure of band wires due to these and other causes and the disastrous results attending their failure have certainly created a prejudice against them among designers and engineers in general. With certain types known as "straight out" or parallel winding it is possible to strongly secure the ends of the coils in regions outside of the clearance, and this, of course, is a great advantage. The chief advantage of the straight tooth, however, seems to be the fact that it permits the use of a machine-formed coil and very much cheapens the cost of winding the armature and generally simplifies its construction and makes more thorough insulation possible. Certain it is that the formed coil permits a very rapid winding of armatures. By means of these devices it is possible to insulate and wind a 100-k.w. armature core complete in less than twenty-four hours. With any other form this work would take several days at best, and if the old wire-wound types were used several weeks would be required. It is probable, therefore, that the straight tooth will become the preferred American practice, and it remains for some inventor to provide a means for securing the coils which is more satisfactory than band wires, which, it may truthfully be said, are a relic of the old days of dynamo building.

Electric Cab Service.

We describe in another column the complete electric cab service which is now operated in the streets of New York City. We find here a vehicle weighing 2800 lbs., and carrying a paying weight not exceeding 400 lbs. With the present storage battery we have of necessity a very heavy vehicle. The battery itself weighs over 1200 lbs., very nearly half the weight of the entire equipment. If we remove the battery and motors we shall have a carriage body weighing in the neighborhood of 1300 lbs., which, though, of course, heavier than the horse-hauled cab, cannot be said to be enormously heavier. It seems that the heavy wheels and solid construction of this vehicle are the outcome not of theoretical judgment and design, but of practical experience. The promotors of the electric automobile have witnessed the failure of a 3-inch pneumatic tire and of various parts in the construction of previous vehicles, which they had thought to be amply strong. In the present construction weight and strength has been very grudgingly added by the designers as it was needed, and until the weight of the electric equipment can be lightened it is perhaps the best that designers can do. We must look for improvement in the reduction of the weight of the storage battery. This once effected, other improvements will follow immediately and naturally. Concerning the handling machinery it will be noted that a carriage body weighing 1600 lbs. seized in viselike jaws by hydraulic rams and lined up with a battery which is apparently much more compact and portable, for the purpose of loading the latter into the former. The suggestion at once is, why not align the battery with the vehicle?

It appears that the handling devices were built to fit the vehicle and, taking this into consideration, the arrangement becomes one of ingenuity and reflects great credit on its designer. The vehicle loads from the end and the moment the batteries are loaded the entire body sinks several inches on its springs. However perfectly we may align the batteries to the vehicle for the purpose of loading, this alignment will be instantly destroyed as soon as the operation of loading is begun. It is obvious, therefore, that the vehicle must be held steady as well as the batteries, and this was done. It may be possible in subsequent designs to load from the top, in which case an ordinary crane will answer, and the present ingenious, but expensive device will be superseded. A movable driver's seat does not seem an insurmountable problem, and would permit the simplification indicated.

Much of the accurate control of this vehicle is due to its admirable brake. This acts upon the armature shaft, which exerts a very small torque as compared with that of the wheels. It can be easily stopped, and if it is stopped, the vehicle is brought to a standstill. Electric railway traction will certainly find in this device a hint in the solution of its own braking problem.

SHUNTS FOR ELECTRICAL INSTRUMENTS.

It is very frequently desirable to construct a low resistance which is a certain ratio to that of an indicating instrument, It may be a galvanometer, a voltmeter or some similar measuring instrument. In the following paragraphs is described a simple, convenient and accurate method for making such shunts as these.

The construction of a shunt can be best understood by reference to the drawing in Figs. 1 and 3, each of which displays a convenient method.

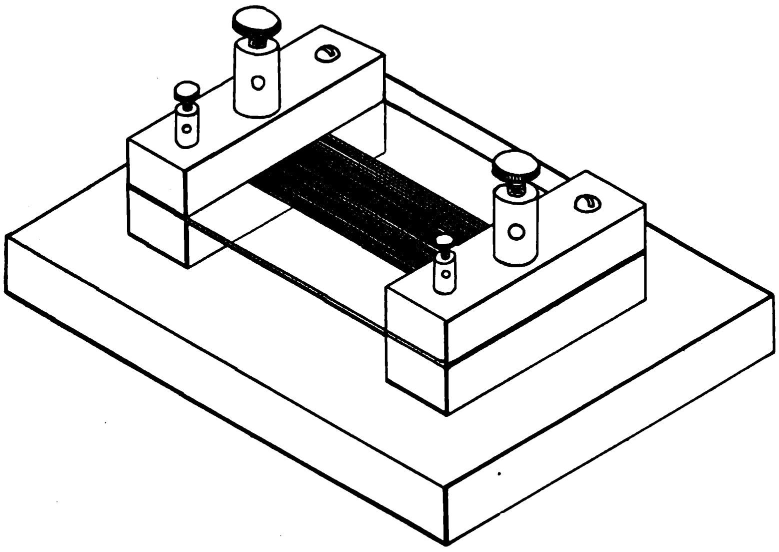


FIG. 1.—CONSTRUCTION OF SIMPLE SHUNT.

Taking first the description of Fig. 1: A board is provided which is reasonably secure from shrinking or warping troubles, and on it are mounted two copper clamps, sufficiently heavy for the purpose. The ends of these copper clamps are tapped and drilled so as to receive a wire, as shown in the figure. A large grip is provided at the one end for the main current wires; and a smaller connection is provided at the other end of the block to receive the wire from the instrument to be shunted. The clamps secure between them a piece of mica, upon which is wound a certain number of turns of high-resistance wire of low temperature coefficient. It will be seen on inspection that the clamps grip the coils of the wire at their ends, and put all of the wires spanning the gap between in multiple. If the blocks are accurately machined so as to make the lengths of all the component shunts equal, the resistance can be calculated beforehand, and the construction should be easily made without involving an error greater than 1 per cent.

In the second form but one clamp is used, the halves of which are secured together by insulated bolts. The mica is wound in the same way as before and a carefully predetermined amount is allowed to project from the jaws of the clamp, but the surplus on the other side of the jaws is carefully trimmed off. In this way a number of loops of wire are connected between the jaws and substantially supported so that they will not interfere with each other. Such shunts as these will pass very large amounts of current in proportion to the metal they contain without heating, as they expose very large surfaces for radiation. This is a valuable feature, because it is highly important that the resistance of the shunt shall not change during its operation, and even though its temperature coefficients may be very low it should not be heated any more than is absolutely necessary.

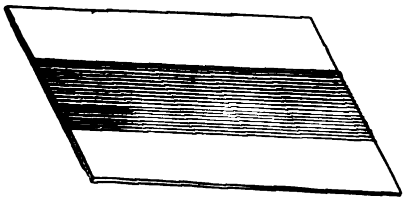
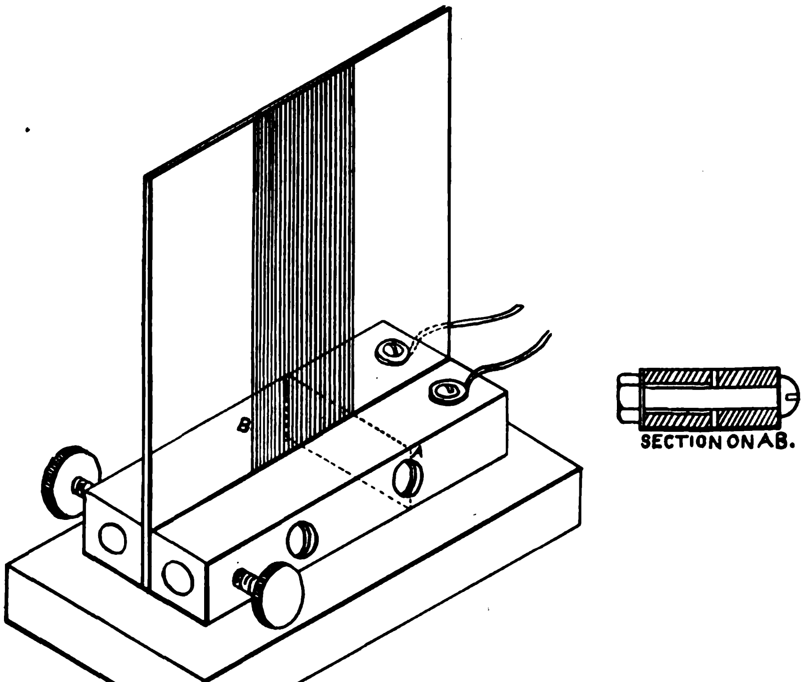


FIG. 2.—SHOWING WIRE WOUND ON MICA.



FIGS. 3 AND 4.—CONSTRUCTION OF SHUNT.

The calculation of such a shunt is very simple, and can best be illustrated by a practical example. Let us suppose, for instance, that we have a voltmeter which deflects completely across the scale when a potential of 1 volt exists between its terminals. Assume also that the scale divisions read to hundredths of a volt. We wish to put this instrument in multiple with a shunt and pass current through the combination, and have the shunt of such resistance that the indications of the voltmeter may be read as amperes, 1-10 of a volt answering as 1 amp. It is evident, then, that if we take a shunt whose resistance is 1-10 of an ohm and apply this voltmeter to its terminals, that it will practically register amperes as just described, for the amount of current the voltmeter takes is a negligible addition to the current in the shunt, being frequently less than 1-50 of 1 per cent.

The problem therefore becomes that of constructing a shunt, the resistance of which shall be exactly 1-10 of an ohm. For this purpose select a high-resistance wire, say of 4 ohms to the foot. Measure a length of some 6 or 8 feet with a Wheatstone bridge, and divide its length in feet by its resistance in ohms in order to determine the feet per ohm accurately. Do not rely on trade tables. They are seldom if ever accurate, especially in the case of special alloys.

Assuming 4 ohms per foot for sake of a figure, it is easy to see that to get a resistance of 1 ohm we should use a piece of wire 3 ins. long, and if we set the blocks of our shunt 3 ins. apart and wind five complete turns upon the mica slip which is bound between them, we shall have ten wires in multiple, each of which measures 1 ohm. Their joint resistance is of course 1-10 of an ohm, which is what we desire. If we were using a shunt of the type shown in Fig. 2, it would be necessary to wind ten turns on the mica and allow the latter to project 1½ ins. from the jaws. The same results would then be obtained.

It is frequently the case that the possessor of a low reading voltmeter desires to make up several shunts for his instrument whereby he can vary the range of its capacity in indicating amperes. For instance, with the 1-volt instrument already described it is easy to see that by using one wire, a 1-ampere instrument will result, with ten wires a 10-ampere instrument; with 100 wires, a 100-ampere instrument, and so on.

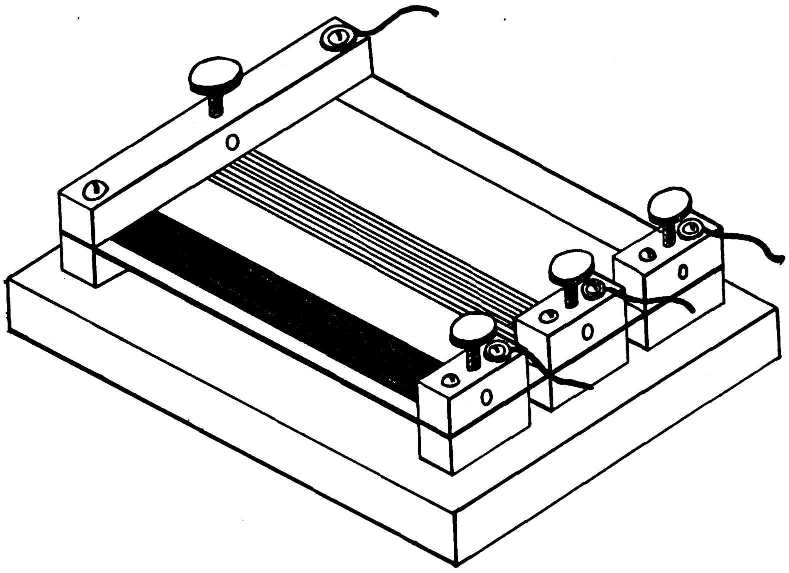


FIG. 5.—CONSTRUCTION OF TRIPLE SHUNT.

Fig. 4 shows a combination shunt board in which this feature is realized in a compact and convenient way. Three shunts are provided, each of which is connected to a common terminal, and the other ends each have individual terminals. The application may be seen at a glance. A very effective way to make heavy shunts is to shape a rod of high-resistance metal in the form shown in Fig. 6. Such a rod is preferably square. Four binding posts are provided—two in the ends to receive the main current, and two at an intermediate distance, which receive the voltage leads passing to the indicating instrument. These leads should be provided with terminals, as shown in the figure, and should be made of a permanent character, as the variation of their length varies, and sometimes to a very great extent the indications of the instrument, if the resistance of the latter is low. It can be easily seen that a shunt prepared in this way is very durable, simple and portable. The method of adjusting the shunt is very simple. The shunt is prepared in the proper way, connected in series with an ammeter whose indications are known to be correct. The instrument for which the shunt is to be calibrated is connected and the distance between the terminals is so adjusted at the start that the indications of the instrument will be slightly low. This may be done by calculation, and an accuracy of 1 per cent should be reached if the resistance of the metal is accurately known. The effective area of the shunt should then be reduced by saw-cuts symmetrically spaced, as shown in Fig. 6. These cuts should be made while the instruments are connected in circuit, and it will be found that the resistance can be very readily increased to cause the readings of the instruments to correspond accurately with each other. The source of current should be a storage battery upon which no other demands are being made. In this way the current will be a practically constant quantity. With a few shunts of this character, which can be built at a trifling expense, the electrical engineer can very largely increase the utility of his measuring instruments.

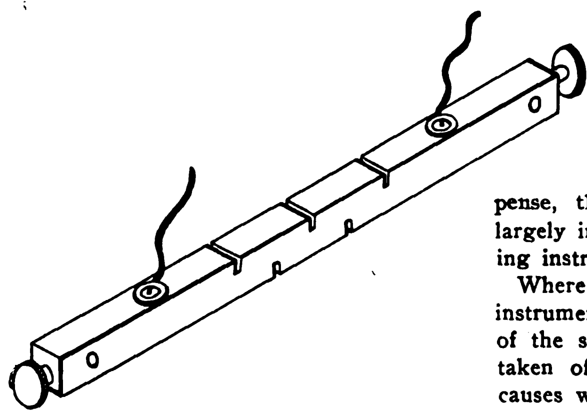


FIG. 6.—BAR SHUNT ADJUSTED BY SAW CUTS.

Where the resistance of the indicating instrument is high, as compared with that of the shunt, there need be no account taken of the reduction of potential it causes when attached to the terminals of the shunt, but where the error cannot be thus neglected the resistance of the shunt is obtained from the following formula:

$$S = \frac{R}{CR-1}$$

where S= the resistance of the shunt, R= the resistance of the voltmeter and C the current in amperes flowing through the circuit when the voltmeter indicates 1 volt. In instruments that are originally built to be used as shunt ammeters it is usually necessary to employ this formula, for their resistance is frequently so low that even an alteration in the length of their leads affects their accuracy.

REPLACEMENT OF DERAILED CARS.

BY WILLIAM HERBERT BONNER.

A derailed street car has often been, within the writer's experience, the cause of great loss of time and money to a railroad company, solely from the fact that no proper means were at hand to quickly restore the car to the rails. Every minute's delay caused by the car being held up costs money, even though it be only because the motorman must make up the time lost. On a road having a close schedule this means that all starts must be made in less time than usual, the result being that the motorman moves his switch over quickly to the parallel connection, thereby using an excess of current, which must be paid for eventually. When the blockade extends to several cars this effect is multiplied. Some damage generally results to the paving alongside the rails, where the flanges of the wheels grind and cut into the material of the roadbed, so that the longer ineffectual attempts are made to guide the car on to the rails by means of stones and fishplates and other odds and ends, the worse it will be for the roadbed. I have watched the crew of a wrecking car struggling for more than half an hour in praiseworthy but misdirected efforts to get a car back on the track. They would jack the car up at each side near the front wheels until the flanges cleared the rails, then let down at one side and push the car over in the hope of it falling down into its proper place. That operation was a long one each time, and the car always settled down in the stones alongside the track.

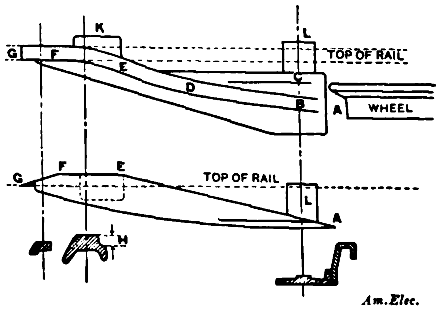


FIG. 1.—WINDING RAIL FOR DERAILING ACCIDENTS.

In the case of steam railroads it would obviously be out of the question to proceed by any makeshift methods to replace derailed cars, and a rational means is adopted which may well be applied to street cars. This consists in providing a winding rail, to be placed under the wheel outside the track, one end of the rail being laid upon the track and the other end on the ground, and the car is then drawn up on the main rails with very little loss of time. The winding rail employed is illustrated in Fig. 1, which shows a plan and side elevation. The rail as here described is not applicable to street railroad purposes, except when the lines run through country roads, where T rails may be used. A modified form will be considered presently, suited to city streets. The lower end A, Fig. 1, terminates in a flat edge perhaps ¼ in. thick, and from this end start two raised sides or flanges

B C, which act as a guide to the entering flange of the car wheel. The flange B is, in fact, the lower end of the winding rail, or guide rail, itself. As these two flanges approach each other B continually rises, so that when the wheel has reached a point (D) where there is no longer any possibility of its slipping down sideways, the flange C will be passed over. At the highest part of the guide, between E and F, the surface is flat, to allow the wheel flange to pass over. The thickness at this point (H) in the sectional view, should therefore take this into account. From F to G is a sharp incline to allow the car to run down to the main rail.

In order to hold the guide rail in position a flange should be provided at K, and at L a strip of wrought iron may be bolted to the frame and carried over the main rail to secure the lower end. The construction of both these pieces will be clear from an inspection of the sectional views given.

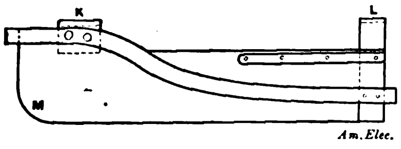


FIG. 2.—LIGHTER FORM OF WINDING RAIL.

This guide rail may be an iron or steel casting, and the illustrations are prepared with that idea in view; but it would be just as well, in the case of a street railroad, to have an oak block made the full length of the rail, from near the point G to A, and a winding strip of wrought iron 2½ or 3 ins. wide and ½ in. thick, screwed down to form the wearing surface. The advantage of such a construction is its lightness, for it would be no easy matter to handle a casting of such a size, and there would be some liability of breakage. The flange K should then be made of a strip of wrought iron also, the general construction being shown in Fig. 2.

In order to provide some means of electrical connection between the car wheels and the rails, the iron flange L should be riveted to the guide rail at B.

No mention has as yet been made of the guide to be used for the wheel on the other side. This need not be of the same shape at all, for the wheel does not require to be lifted over the rail. A plain wooden block, of the form shown in Fig. 3, will therefore suffice, and the wheel will run up on its flange. This will, of course, produce slipping, because the wheel on the other side is running on the tread, but if the block is faced with wrought iron there will be no trouble on this score. A block could be made of such a shape as to allow the wheel to run on the tread, but this would necessitate making a curve of the same shape as that on the other block, and it would also be necessary to set the two blocks more accurately with regard to each other, in order that the two curves might correspond.

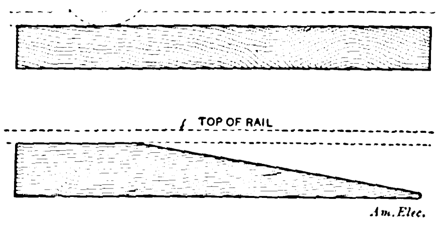


FIG. 3.—WOODEN BLOCK TO ASSIST IN REPLACING CARS.

Either the front or the rear wheels of a car are pretty sure to be close to the rail, so that usually no other operations are necessary than the one indicated; but, if this is not the case, it is an easy matter to move the car along by means of a crowbar until sufficiently near to the rails. The guide rail described may of course be used on either side of the track, as it is only necessary to run the car backward on to the track if it has left the rails on the right-hand side.

The length of the guide rails is determined principally by the distance from the top of the track rail to the ground. This may be only 1 in. or it may be the full height of the rail from the ties. In the first case the guide rail may be very light and short, while in the second case it may be 2 ft. 6 ins. or 3 ft. long. When the road level comes nearly to the top of the rail, only a slight modification of the above design is required. The total length becomes less, for the wheel has to be raised a smaller distance, and the thickness of the underlying block is also reduced, being merely that required to make up the difference between the two levels. In fact, a light guide rail of such a pattern may be used in many cases by supporting the raised corner M, Fig. 2, by means of a block of wood. The strip L may also be omitted, and contact with the rail may be secured by a through connection from the strip K.

ELECTRIC RAILWAY PRACTICE.

CAR WIRING.

BY WALTER MUNROE.

During the past few years the equipments of electric cars have undergone a marked change, and this change has been reflected in the varied methods of car control and consequently in the car wiring.

At the present time, however, the various types present considerable similarity, present practice having settled upon the method of using two controllers, one for each end of the car. These controllers are connected to each other by a number of flexible insulated wires inclosed in cotton hose. The ends protrude some distance beyond the end of this hose and the wires are tapped at convenient points with leads for the motors, resistance coils and similar devices. It is the object of this article to give some ideas on car wiring, and also to show their application.

Starting with the trolley wire, we follow the current down to the trolley base. Here the roof wire is tapped on. This wire runs along the roof through two overhead switches and then down near one end of the car to the floor. It then goes through some circuit-breaking device, a lightning arrester and a choking coil to the cable.

In the roof wiring there is opportunity to use various methods. Starting from the trolley base, we may use a well insulated wire and carry it toward the side of the car on the upper deck, until we reach a point just outside the ventilating windows. Then pass it through a hole down parallel to the windows to the lower deck. Continue it along, cleating it well up under the overhanging roof to the hood, then round the corner and in this direction until in line with a hole bored just outside the base of overhead switch fastened underneath. The wire enters this switch through a hole in the hood and leaves through another directly under the overhanging upper deck, and along on the other side of the car to the overhead switch at the other end. Leaving this it comes back along the hood parallel to the entering wire, up to the windows, and from thence down to the car floor and into the cable.

Another method is to start from the trolley base, carry the wire directly along the upper deck to the window at the end, thence through a hole in the roof to the hood and through an overhead switch. From the switch it passes back parallel to the first wire to the upper deck, across and by a similar hole through the second switch. From this point the wire is run just as in the previous case.

Where the wire traverses a length of roof exposed to the weather, it may be well to cover it with a heavy canvas strip lashed to the roof. This should be well painted, especially along the edges, in order to insure a waterproof joint. This second method necessitates boring more holes through the roof, with consequent chance of leakage through the ventilating windows. If a well insulated wire is used, it may be safely left uncovered. The only exposed portions are the short stretches on each hood.

The holes where the wires go through the roof should be lined with canvas, well painted or white leaded, and this canvas should be tacked down around the wire and hole. This point should be made water tight. When running the wire near the ventilating windows iron rods should be avoided by giving the wire a wide sweep and securely cleating in that position. In all car wiring, either on the roof or under the floor, all iron work, whether in direct connection to ground or not, should be given as wide a berth as possible.

On open cars the trolley wire is oftentimes brought from the roof down a groove cut in a corner post. It should be effectually covered up and protected by a piece of molding. Great care should be exercised in protecting from abrasion from any of the metal fixtures that may be fastened to this post.

In the closed cars, the wire can very conveniently be run down through the door casing.

No attempt will be made in this article to give the details of the diagram of any of the prominent manufacturers; but a method of wiring applicable to all will be described. The fuse box should be so placed as to be easily accessible. It should in no case be placed where the flash or noise will endanger or frighten passengers. There have been many cases of injury to passengers, panic-stricken at the pyrotechnic display of a violently blown fuse. The practice of placing fuse boxes under the seats in closed cars, in plain view of the passengers, is not to be commended. The lightning arrester should be tapped in next to the fuse box, and its ground connection should be of ample size and as short as possible. The place occupied by the lightning arrester should be chosen with some care, in order that it may be protected from injury and from mud and water from below.

There is an old type of lightning arrester which is still used in many cases, where it is necessary to place it in an exposed position. The air gap in the ground circuit is in a slit between heavy slate plates. The gap points are of metal. When correctly installed, it is so fastened that the plane of the slit is vertical and the longest dimension of the arrester horizontal. Then this prevents any foreign matter from staying in the slit or air gap, and also the retention of any melted matter from the gap points in case of a heavy discharge. A better way is to place the arrester in a wooden box, somewhat greater than its dimensions, and lined with heavy asbestos paper. The box should have ample ventilating holes in the vicinity of the slot. This box can be hinged to a baseboard and fastened down with a hook and eye. so as to facilitate inspection and cleaning. The baseboard can then be fastened to a floor timber, hinged at the top, so that the box can be readily opened. The location of the resistances is important. They should be placed so as to be out of the way of wheel-throw and the splashing of mud and water. At the same time, they should be close to the cable at the point where the resistance leads come out. This will save wire, labor in cleating, lessen confusion and minimize losses.

If there are a number of cars of the same type, it would be well to look over the floor timbers carefully and determine the best place for the resistances, choking coil, lightning arrester, etc. This being determined, the plan should be used as a sort of standard for similar cars.

The lead wires into the resistance boxes should enter in such a way that there is little chance of grounding on the frame due to abrasion. Loop the wires, if necessary, but cleat up so that there is as little motion as possible. There is always a chance of the resistance boxes becoming hot enough to scorch the floor of a car. To provide for this the "bays" in which they are installed may be lined with heavy asbestos sheet.

The method of connecting the motor leads to the cable taps is important. There should be sufficient slack to allow for all motion of motor relatively to the car floor, but no more. They should be covered with an extra heavy braided insulation. It is a good plan to slip over them a length of flexible conduit used in interior wiring, Rubber tubing is not to be commended, as it soon deteriorates.

The prepared cables, containing the wires for the controlling apparatus of electric cars, are frequently assembled at the car barns. A stranded, well insulated wire, having a double braid covering, is often used in this work. A flexible wire is much better, as it is much easier to handle and there is less danger of weakening the wire due to frequent bending. Wires equivalent to about No. 6 B. & S. are suitable for a double 25-h.p. equipment. Six or seven such wires may be drawn into 1½-in. cotton hose, this serving the purpose of assembling the wires into a compact form, and also protecting them from moisture, dust and dirt. After the wires are in the hose, it is a good plan to give the cable a good coating with insullac or some similar compound, as an additional protection.

Before starting work on the cables it is necessary to know the total length of the cable measured from just inside each controller base, and also the distance (measured along the cable) from one end of the car to the beginning of each set of taps for motors, resistance boxes, etc. To do this a flexible cord may be used, placing it along the line that the completed cable is to occupy. The positions where the taps are to emerge can then be determined.

It should be remembered that the canvas covering should extend through the end frame timber just into the controller base, hence all distances along the cord should be measured from this latter point. The wires themselves, of course, extend beyond the hose sufficiently to connect with the connection board of the controllers. If the hose and wires are made too long, the taps may be placed in their proper positions and the cable anchored at these points. Then any slack may be taken up by looping the cable out of its direct path. By this method you are sure of having enough wire and one measurement may be made to serve for different types of cars. It is, however, a rather slipshod method of working and requires extra wire.

The taps should be placed about 3 ins. apart and should have a double or preferably a triple-braided covering. They should project at least 3 or 4 ins. beyond the side frame timbers. After the distances have been determined on the flexible cord before mentioned, it will be found convenient to lay them off on a floor or long bench, as the wires can then be fixed by direct comparison.

Having determined the proper length, those points are to be bared of insulation 1½ to 2 ins.) on each side of the place of attachment of the tap. They should then be bent into a "U" shape at this point, for this will be found very convenient for treating them with soldering compound and then dipping them into a ladle of melted solder. They should be given a good smooth, solid coating. The bared ends of the stranded taps should be separated into two equal groups of wires, and these groups wound in opposite directions around the tinned wire. A careful joint should then be made by pouring or dipping. It is of considerable importance that joints be very well made, for there is always a chance for heating and burning of insulation, with consequent opportunity for a short circuit. The joints should then be covered with good insulating tape and treated with "insullac" on every layer until the last is of same diameter as original wire. If much difficulty is experienced in getting the last wires with their attached taps into the hose, the following method may be used:

The last one or two wires may be pulled in without their taps attached. They can then be pulled out sufficiently far (through the slit in the hose made for the group of taps) to permit the last taps to be put in place. A pull from both ends of the wire will then snap them back into place. The slits are then sewed up (overlapped) closely around each tap and treated with "insullac."

The following is a convenient method of placing the cables in position: Put the ends of the cables through the holes in the platform and wedge them firmly in place with wooden wedges. Then bring the groups of taps to their proper places and fasten the cable securely at these points. After that, any slack may be taken up as conveniently as possible.

There are various methods used to fasten the cables to the floor and timbers. One method is to use a cast iron strap of a U shape, with projecting ends for fastening to the wood work. When using these, the tendency is either to leave the cable loosely chafing about or else to have it so tight as to crush the insulation or covering. In either case there is chance abrasion.

A very good method is to use strips of waterproofed canvas, rather heavy, and 1½ ins. wide. These are cut in length sufficient to surround the cable easily and leave enough for a screw fastening through both ends. These are strong enough, for they can be used double if necessary. With these, each point fastened may be made to grip the cable and prevent vibration.

The actual connection of the motors, controllers and accessories to the cables is very easily completed by referring to the diagrams furnished with the apparatus.

CONNECTING ROTARY TRANSFORMERS.

Unlike the direct current dynamo it is not always safe to connect rotary transformers for series operation. They may be connected and will operate well in parallel. A moment's thought will show why series operation is impossible if the rotaries are fed from the same static transformer. The D. C. brushes of the rotary are in direct metallic connection with the transformer terminals and to provide another rotary taking current from the same transformer would be analagous to providing four terminals to a battery and connecting the + and — terminals together with the expectation of obtaining double voltage from the other two. Where the rotaries are fed by separate static transformers series connection is permissible, and this is also the case where the rotaries have independent windings. In the latter case there is also the advantage of adjustable direct current voltage by varying the field strength. With the combined winding rotary varying the field simply alters the power factor without changing the D. C. voltage.

EXPANSION OF STEAM PIPES.

BY WILLIAM BAXTER, JR.

That metals are expanded by heat is as well known as that a hot fire will boil water; nevertheless, many men who set up boilers and engines appear to totally ignore the laws of expansion and make the pipe connections wholly with a view to reducing the cost to the lowest point, or else produce the most pleasing effect upon the eye. Most of those who follow this course are men who have never had occasion to install a plant of any magnitude, and consequently never having had any trouble from the effects of expansion, take it for granted that in some way not known to them the elasticity or some other property of the iron counteracts the thermic action. There are many who actually believe that although a steam pipe will elongate when heated by the steam, if free to move, that if constrained the elasticity of the metal will enable it to compress to the same extent as it is expanded, so that upon the whole its length remains unchanged. This notion, it is hardly necessary to say, is entirely incorrect, and those who believe it fail to notice that every case that apparently substantiates it proves just the contrary, and if properly investigated it would be found that the pipes run in such a direction that they can spring sufficiently to compensate for the expansion. When the pipes cannot spring as much as is necessary they soon begin to leak, and from that time onward continue to be a source of annoyance until their location is changed. A pipe connnection in a straight line from the boiler to the engine is hardly possible, owing to the fact that the outlet from the former is several feet higher than the inlet in the latter, therefore there will be at least one bend, and if there is not too much difference between the parts of the pipe on each side of the bend there will generally be little or no trouble experienced from the effects of expansion.

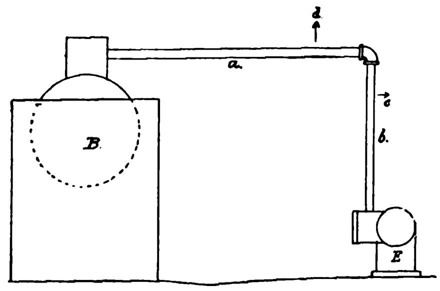


FIG. 1.—SIMPLE STEAM PIPE CONNECTION.

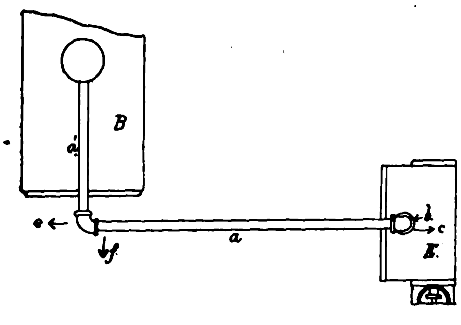


FIG. 2.—MODIFICATION OF FIG. 1.

About the simplest manner in which an engine can be piped is as shown in Fig. 1, in which B represents the boiler and E the engine; a and b being the pipe. If the section b is very short, the displacement of a in the direction of the arrow d, caused by expansion, will be small and will not produce a serious strain upon the joints at the ends of a; but the movement of b, in the direction of the arrow c, will be sufficient to strain the joints at the bend and at the top of the steam chest enough to cause them to leak, and if b is short enough and a sufficiently stiff, may actually result in breaking the pipe b. If a and b are of equal length, the strain upon the joints will be reduced to the lowest point. The longer a and b are the less the strain will be, although, within very wide limits, the length makes very little difference, owing to the fact that as the length increases the side displacement due to expansion increases.

When the pipe has two bends, as in Fig. 2, the strain impressed upon it by expansion is greatly reduced, for then the section a′ can move in the direction of arrow e, thus reducing the displacement of b in the direction of c. In addition to this, the elongation of b can be compensated for in part by the movement of a and a′ in the direction of arrow d, in Fig. 1, and in part by the twisting of a′. In the same way the elongation of a′ can result in moving a and b in the direction of arrow f, and also in giving b a slight twist.

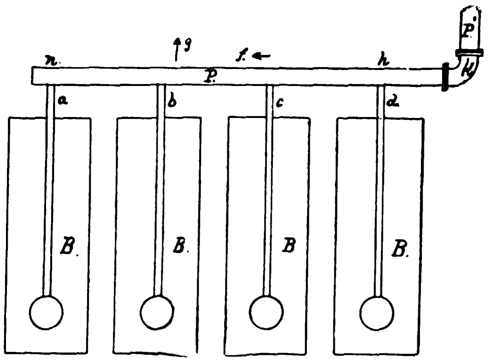


FIG. 3.—HEADER CONNECTIONS.

An engine piped as in Fig. 2 is not likely to give trouble on account of leaky joints, but if piped as in Fig. 1 it almost surely will if there is a considerable difference between the lengths of sections a and b.

In such cases as the foregoing, where one engine is connected with one boiler, it is more difficult to run the piping so as to be injured by expansion than to so dispose it as to be unaffected; when, however, a number of boilers or engines, or both, have to be connected in one general system, as is illustrated by the diagrams, Figs. 3 and 4, the conditions become reversed, and unless the piping is planned by one who is familiar with the laws of expansion, and has due regard for them, serious results are almost sure to follow. In Fig. 3 the boilers B, B, B are connected with the main steam pipe P by the pipes a, b, c, d. Studying this diagram we can see that pipe P will be elongated by expansion, and if held immovable at the end from which P′ leads, its elongation will result in bending to the left all the pipes leading from the boilers. The pipe d will be bent only a small amount, as it is only affected by the expansion of the length, h k, but pipe a will be bent much more, being acted upon by the expansion of the entire length of pipe P from k to n. Unless the pipes a, b, c and d are of considerable length, the movement of a may be more than its elasticity will permit, and the result will be that it will soon leak at the joints. From this it can be realized at once that it would be impracticable to move the pipe P down to the point where the small pipes tap the boilers, and make a direct connection, for under such conditions the expansion would either cause the boilers to move bodily, or else it would break off the connections between them and the steam pipe. Not only must the pipes a, b, c, d be provided, but their length must be so proportioned with reference to the length k n of pipe P that the displacement of a will not be enough to strain the metal beyond the elastic limit. The expansion of the pipes a, b, c, d will move the main pipe P in the direction of the arrow g; therefore P′ must be so arranged that it can move endwise as much as may be necessary to provide for the expansion of the small pipes.

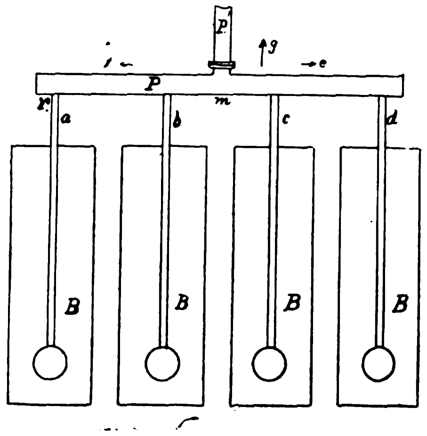


FIG. 4.—HEADER CONNECTIONS.

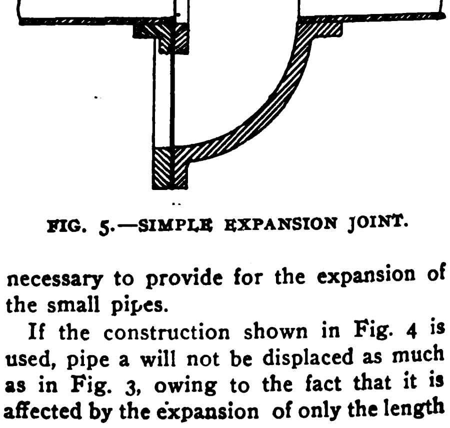


FIG. 5.—SIMPLE EXPANSION JOINT.

If the construction shown in Fig. 4 is used, pipe a will not be displaced as much as in Fig. 3, owing to the fact that it is affected by the expansion of only the length m r of P, which can be less than one-half of k n in Fig. 3. Since the displacement of a is very much less, the length of the connecting pipes a, b, d, c can be greatly reduced, and as a consequence the displacement of P in the direction of arrow g will be reduced. The transfer of P′ from the end of P to the center, as shown by the foregoing, will render possible the reduction of the length of the pipes a, b, c, d, and in addition, will reduce the displacement of P, and thus make it easier to compensate for expansion beyond this point.

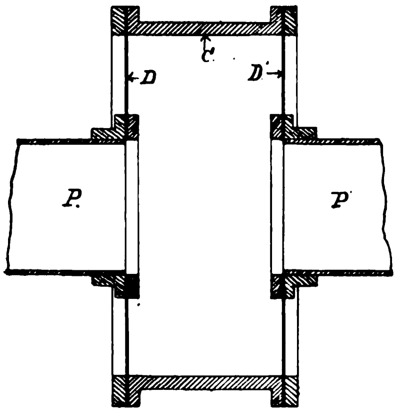


FIG. 6.—DOUBLE DIAPHRAGM JOINT.

From a superficial glance anyone would be able to see that the arrangement of Fig. 4 is superior to that of Fig. 3, but it is not until we investigate carefully that we are able to note the decided superiority. As in Fig. 4 the side displacement of a is less than one-half as much as in Fig. 3, the length of the pipes connecting the main pipe with the boilers can be cut in two, and this not only reduces the piping to a more compact form, but also reduces the displacement of P in the direction of arrow g to one-half, which means that the movement in P′ to be provided for is one-half as much as in Fig. 3.

When the number of boilers is not over four or five, and the size of the pipes a, b, c, etc., not over 4 ins., the construction shown in Figs. 3 and 4 can be used; but when there is a long string of boilers, or when their size is such that the pipes a, b, c, etc., are larger while the length has to be reduced, then the expansion cannot be taken care of by the side springing of the pipes. In such cases it is necessary to provide some form of expansion joint. In some cases the piping may be so arranged that the greater part of the expansion can be provided for by the displacement of the pipes, so that one joint will be sufficient; in other cases, however, it may be necessary to provide several expansion joints. A simple form of expansion joint is that in which one pipe slips inside of the other, a stuffing box similar to that used on the piston rod being provided to make a steam-tight fit. For small pipes this answers very well, but for large ones it is expensive and more or less troublesome to keep in good order. Figs. 5 and 6 show modifications of simple diaphragm expansion joints, that are well adapted to many cases, particularly where the movement to be provided for is not very great. In Fig. 5 P and P′ are the two parts of the pipe joined by the expansion joint. Upon the end of P is secured the flange b, and upon P′ the casting c. A diaphragm, D, is secured to flange b by means of the ring a and suitable bolts; and to the casting c, by means of the ring e. This diaphragm is generally made of copper, and is corrugated in circular lines so as to increase its flexibility. When one diaphragm is not sufficient to provide all the movement necessary, the construction of Fig. 6 is used, in which, there being two diaphragms, the movement is doubled. Neither one of these designs is well adapted to high pressure, owing to the fact that unless the diaphragms are thin they cannot spring to any extent, and if thin they will not withstand much pressure unless the diameter inside of casting c is not much greater than the outside diameter of b. This difficulty, however, can be overcome by resorting to the construction shown in Fig. 7, which differs from Figs. 5 and 6 in being supplied with bridge pieces, s s, which reinforce the diaphragms. These pieces, which are of sectoral shape, as shown at A, are supported at the outer ends by the overlapping edge b of the ring B, and at the inner ends by the overlapping edge a of flange E. The pressure of the steam acting from within forces the diaphragms D against the supporting bridges s s; thus these carry nearly all the strain, and the diaphragms only need be of sufficient thickness to resist the pressure acting over a comparatively short distance near the inner and outer edges, and also to resist the flattening out of the corrugations against s s. As with this construction the diaphragms are relieved of nearly all the strain, and as there is no difficulty in so proportioning the bridges s s that they may carry any amount of pressure, the distance a b spanned may be any amount desired; therefore, the movement obtainable from a single diaphragm may readily be made as much as 1 or 1½ ins. for a joint suitable for a 10-in. pipe.

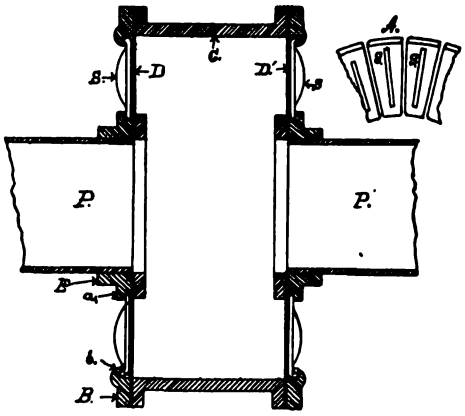


FIG. 7.—REINFORCED DOUBLE DIAPHRAGM JOINT.

In order to obtain the greatest amount of movement from these joints it is necessary that the length of the pipes be such that when cold the diaphragms will be drawn outward at the center to a distance equal to one-half the total movement, then when the expansion reaches one-half the maximum amount they will be in the position shown in the figure.

To be able to determine whether it is necessary to resort to expansion joints or not we must know the rate at which iron expands with rise in temperature, and also the extent to which pipes can be deflected sidewise without weakening the joints. The elongation of steam pipes carrying 100 lbs. pressure may be taken roughly as equal to two-hundredths of an inch per foot of length, and the deflection for pipes under 5 ins. diameter as equal to fifteen-hundredths of an in. per ft., divided by the diameter of the pipe in ins. From these figures we can see that, roughly, a pipe 12 ft. long will expand ¼ in. in length, and if its diameter is 3 ins., equal to 3½ in. outside, the safe side motion will 12 times 15-100 in., divided by 3½, or a little more than ½ in. Applying these figures to Figs. 3 and 4, we will find that if the pipes a, b, c, d are 12 ft. long and 3 ins. in diameter and 10 ft. apart, the expansion of pipe P in the latter figure will not be more than the permissible side movement of the smaller pipes, but in Fig. 3 it will, for in this construction the length of P from a to d is 30 ft.; therefore, from P′ to n probably 35 ft.; which would make the elongation about 7-10 in., or nearly 50 per cent more than pipe a could safely withstand. Hence, to make this construction perfectly safe it would be necessary to increase the length of the small pipes, or if this cannot be done from lack of room or any other cause, to place an expansion joint in P between pipes c and b.

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AMERICAN TELEPHONE PRACTICE.

LUMINOUS SIGNAL SWITCHBOARDS.

BY KEMPSTER B. MILLER.

In the last two articles in this series a somewhat detailed description was given of the various types of so-called self-restoring switchboard drops. In all of the telephone exchange systems so far outlined the various signals for attracting the attention of the operator have been given by some form or another of electro-mechanical annunciators, of which those of the self-restoring type represent the highest development. An entirely different class of signals has recently come into very general use, especially by the Bell Company, namely, the incandescent lamp or luminous signal, as it is termed. The use of the incandescent lamp as a signal in telephone work was, so far as I am aware, first proposed by Mr. J. J. O'Connell of Chicago. Luminous signals and, in fact, incandescent lamps, had however been used at an earlier date for signaling in other lines of work.

The advantages of the incandescent lamp over the electro-mechanical signal are many, and among them may be mentioned the following: First, they are capable of attracting the attention of an operator with much more certainty than the ordinary mechanical shutter; second, they are entirely free from mechanical complication, and therefore unlikely to get out of order or to fail in action, unless entirely destroyed; third, they are much more compact than even the simplest electro-mechanical signals; fourth, they are entirely automatic in their operation, being always restored to their normal condition by a cessation of the current through them; fifth, by the use of various colored glass in front of them they may be used in the same board as indicating separate kinds of information; sixth, they are easily replaced when destroyed; and seventh, they are as cheap, if not cheaper, than the high-grade tubular drops now in such common use.

Obviously there two different methods of associating incandescent lamps with the circuits of the subscribers' lines. The first of these and, without mature consideration the most desirable, is to place the lamp directly in the circuit of the subscriber's line and operate it automatically by a change in resistance in the line, brought about by the removal of the subscriber's receiver from the hook. The second is to have the lamp in a local circuit controlled by a relay directly in the line circuit, which relay may be operated by an ordinary subscriber's magneto generator or by a source of current at the central office thrown into action by a change of resistance at the subscriber's station.

A system using the first method is shown in Fig. 1, in which the subscriber's apparatus is shown at S and the central office apparatus at C. The line wire 2, forming one side of a metallic circuit, is connected with the tip spring t of the jack J, and passes through an incandescent lamp, l, and through an inductive resistance, h, to one pole of a battery, i. The other side, 3. of the metallic circuit passes through an inductive resistance, g, to the other pole of the same battery. When the subscriber's receiver is on its hook the circuit at the subscriber's station between the two sides of the line wire is completed only through the high resistance call-bell, e, and as this bell has a resistance of about 1000 ohms, the current from the battery, i, through the line circuit is not sufficient to illuminate the lamp, l. When, however, the subscriber's receiver is removed from its hook a circuit of low resistance is closed in parallel with the bell magnets, e, this circuit including the secondary winding, c_2, of the induction coil, and the receiver, b, in series. As this circuit may readily be made less than 40 ohms, sufficient current will be allowed to flow from the battery, i, to illuminate the signal, and thus attract the operator's attention. Another feature of this system and one which it was not the purpose of this article to illustrate, but which, owing to its extreme ingenuity, should be mentioned in passing, is the peculiarity of the arrangement of the battery, d, with respect to the circuits of the subscriber's station. It will be obvious that whatever current passes through the bell magnets, e, from the battery, i, at the central office, must also pass through the battery d. This consists of two cells of storage battery of the Plante type. Whenever the apparatus at the subscriber's station is not in use this battery will therefore be receiving a charge from the central office source, the strength of the latter and the resistance of the circuits being so proportioned that the storage cell will receive a constant charging current of about .02 of an amp. When the subscriber's apparatus is put in use, however, the battery is thrown in a local circuit including the primary winding, c^1, the transmitter, a, and the contact point, f^2, and will then perform the functions of an ordinary primary battery in connection with the transmitter. The chief novelty in this system consists in the alternative function which this battery, d, may perform. It is well known that if a storage cell of the Planté type becomes almost or quite discharged it will develop a counter e.m.f. when a current is sent through it in the direction necessary to charge it, and that this counter e.m.f. will be very nearly equal to the e.m.f. of a similar cell fully charged. Supposing, now, that from some cause or other the cell, d, becomes discharged to such an extent that it is incapable of furnishing enough current to operate with the transmitter, a, in the usual manner. In this case, when the receiver is raised, the current from the battery, i, at central, which tends to pass through the storage battery, will meet with a considerable counter e.m.f., which will compel most of the current to pass through the secondary c^2, receiver b, wire 4, wire 6, contact f^2, wire 5, transmitter a, primary coil c^1, and to the line wire, 3. The transmitter, a, will therefore receive current from the battery, i, sufficient to operate it, and yet it will be operating with all the advantages to be derived from a local circuit and induction coil; for, although the current operating it comes from the central office, any fluctuations in this current caused by the transmitter, a, will pass through the low-resistance battery, d, which will act in this case very much in the same manner as a condenser. This system is the invention of Mr. C. E. Scribner of Chicago.

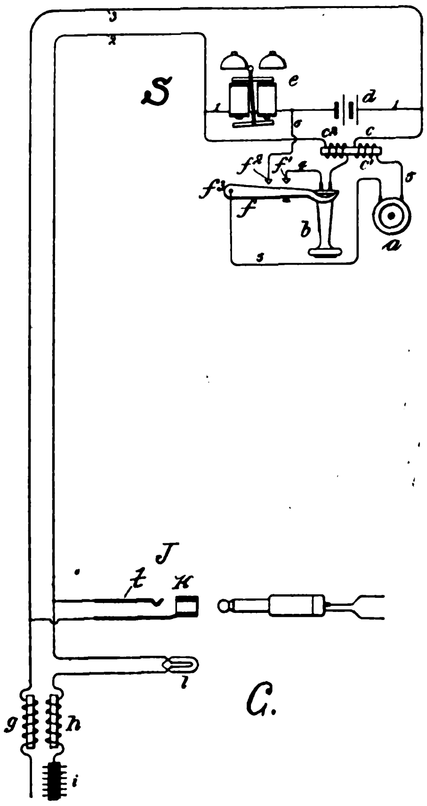


FIG. 1.—CONNECTIONS FOR LUMINOUS SIGNAL.

To return now to the luminous signal feature, we find ourselves confronted with several rather serious objections; in the first place, the resistances of no two subscribers' circuits are the same, owing to the differences in the lengths of these circuits and other causes, and therefore either the resistances, g or h, or that of the bell magnets, e, will have to be varied in each case in order to insure the proper amount of current passing through the lamp, l. This is a feature easy to overcome, and a much more serious one is that arising from crosses between two line wires from any source whatever, such a cross, of course, always subjecting the lamp to an undue amount of current, and therefore burning it out. This latter objection has proved so serious as to cause the abandonment of the plan of including the lamp directly in the line circuit in nearly every case where it has been tried. Of course, for underground systems this objection is not such a serious one.

Passing now to the second method of associating the lamp signal with the line circuit, reference will be made to Fig. 2. This shows the circuits of three subscribers' stations, S, S^1 and S^2, these circuits being connected with the central office by the metallic circuits, 1, 2. The line wire, 1 in each case passes to the sleeve spring, d^2, of the spring-jack, J, and thence through the relay contacts c^1, to the ground. The line wire, 2, passes in a similar manner to the tip spring, d, thence through the relay contacts, c^2, the winding of the relay, b, and the battery, a, to the ground. The signal lamp, e, is in each case included in a local circuit containing a battery, f, common to all lamps, and the contact, 4, of the relay, b, belonging to its line. The relay, c, of each line which controls the contacts, c^1 and c^2, is known as the cut-off relay, and is included in a local circuit through the jack thimble, d^1, and the plug contact, m, with the battery, n, whenever a plug, l, is inserted into a jack for making connection with the line. The two sides of the line at the subscriber's station are permanently closed through a high-resistance bell, B, and a condenser, C, the latter being of considerable capacity, so as to allow the alternating currents from the calling generator at the central office to pass through it and operate the call bell in the usual manner. The high impedance of the call-bell magnets, however, prevents the short circuiting of the voice currents when the receiver is removed from its hook. The call-bell circuit therefore presents an open circuit to the direct current from the battery, a, thus normally insuring a condition of no current upon the line wire. When, however, the receiver at the subscriber's station is removed from its hook, a path of comparatively low resistance is formed between the two low line wires, and a current proceeds from the battery, a, through the relay, b, contact, c^2, line wire, 2, to the subscriber's station, back by line wire, 1, through relay contact, c^1, and by ground to the opposite terminal of the battery, a. This current is sufficient to operate the relay, b, and unlike the case where the lamp was used directly in the line wire, a considerable variation in the amount of this current is allowable. The operation of the relay, b, closes the circuit of the lamp, e, through the following path: From the battery, f, through the relay, g, wire, 5, common wire, C, lamp, c, wire, 3, relay armature, 4, and back by ground to the opposite pole of battery, f. For the purpose of clearness the relay, g. need not be considered at all at present, as it has nothing to do with the operation of the lamp, e, and we may therefore consider one pole of the battery, f, to be connected directly to the common wire, C. The closure of this circuit illuminates the lamp, e. The next step in the operation of the system is the insertion of the plug, l, into the jack of the line on which the signal is displayed. The insertion of this plug closes the circuit through the relay, c, over the following path: From the battery, n, wire, 10, plug sleeve, m, thimble, d^1, wire, 9, relay coil, c, to ground and back to the opposite pole of the battery, n. This causes the relay to attract its armature and break both of the contacts, c^1 and c^2, thus accomplishing a double purpose, the first of which is to break the circuit through the relav, b, and thus cause it to release its armature, 4, breaking the circuit through the lamp, e; and the second of which is to cut off both sides of the line circuit, 1, 2, beyond the spring-jack, J. This latter feature is a very important one, since it removes all difficulty from cross talk and other troubles in the auxiliary circuits of the central office.

The circuits illustrated in Figure 2 are substantially those in common use by the Bell Company in their lamp signal exchanges, so far as the circuits of the relays and lamps are concerned. Several different modifications of the circuits at the subscribers' stations have, however, been used. The subscribers' stations may or may not include local batteries, and the tendency of practice is now to do away with these entirely and to supply current from central office for the operation of the transmitters as well as for all signaling purposes; this feature, however, will form the subject of subsequent articles.

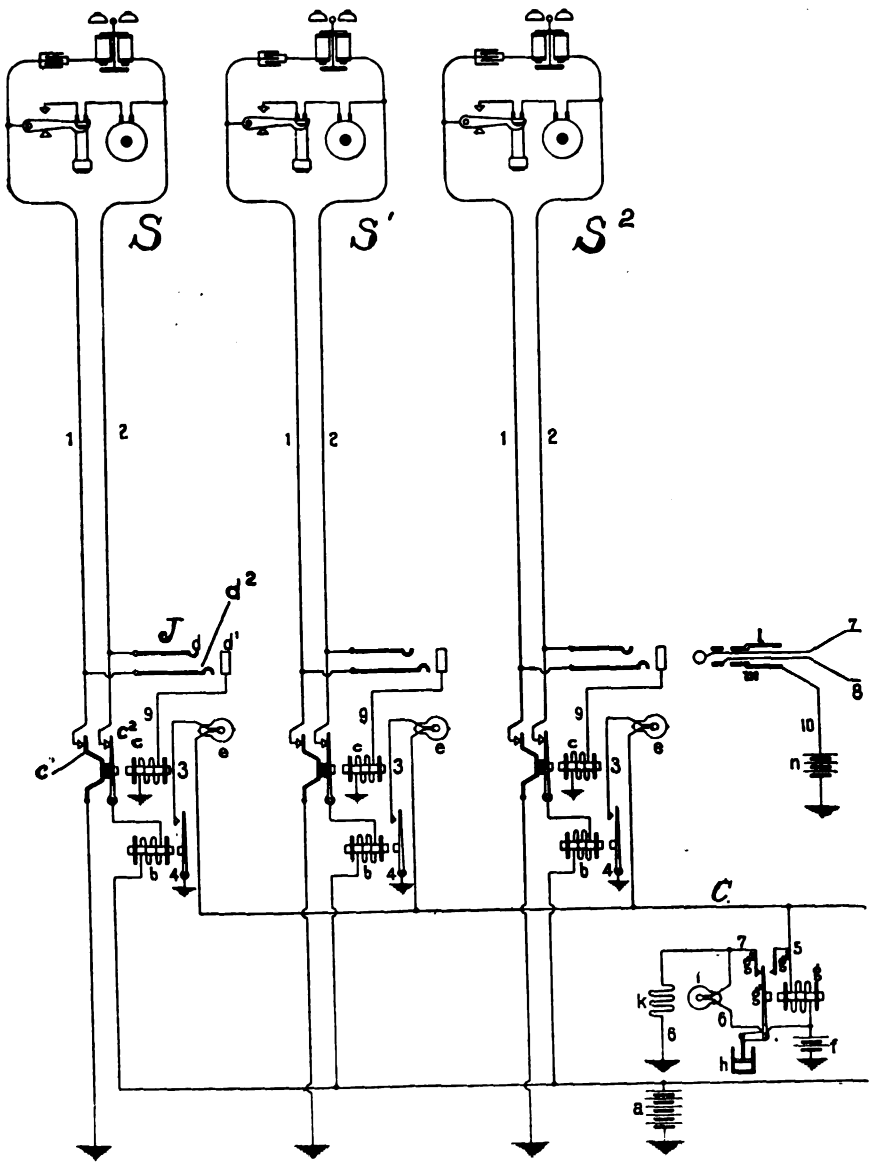


FIG. 2.—SECOND METHOD OF LUMINOUS SIGNAL CONNECTIONS.

The relay, g, and its associated apparatuses form a very interesting addition to the system as outlined. It is found desirable to use what are termed pilot lamps for certain groups of line lamps, for the purpose of attracting the operator's attention more surely to a signal on her board. If two or more signals are displayed at once, but one of them may attract the attention of the operator, who might therefore neglect the other. Pilot lamps are used in such connection that they remain lighted as long as any one of the line lamps in their group are lighted, and as they occupy a very conspicuous position and are as a rule brighter than the others they cannot escape the operator's attention. Obviously it would be a serious objection to put a relay for operating such a pilot lamp in the common wire, C, of the local circuits of the lamps, e, for the reason that the fall of potential or drop through such a relay would vary, according to the amount of current passing through it, and if several of the lamps, e, were operating at the same time, they would probably not therefore receive enough current to properly illuminate them. The relay. g, is therefore included in circuit with battery, f, and means are provided whereby its resistance will be short circuited the instant it is operated. To accomplish this, the armature, g^1, makes contact with the point, g^2, as soon as it is attracted, thus short circuiting the resistance of the coil, g. At the same time it breaks contact with the point, g^3, and thus allows the current to flow from the battery, f, through the lamp, i, and resistance, k, thus illuminating the lamp. In order that the armature, g, may not fall back against the contact point, g^3, as soon as the coil, d, is de-energized by being short circuited, a small dash pot, h, is provided in connection with the armature to render its movements sluggish. Thus before the armature, g^1, has time to move very far away from the point, g^3, owing to its sluggish action, it will be at once attracted again, and the interval during which the resistance coil, g, is in circuit with the common wire, C, and the lamps, e, is so small that it does not have time to affect these lamps. This system is also due to Mr. Scribner, and both it and the one shown in Fig. 1 form interesting examples of the highly skillful manner in which he always solves his telephone problems.

The incandescent lamps commonly used for signaling purposes and telephone work are of the type shown in Fig. 3; the lamp is about ⅜ of an in. in diameter, and 1¼ ins. long over all. They are commonly built for 10 or 20 volts pressure, the tendency being rather to increase the voltage than to decrease it. At first lamps of 2 and 4 volts were used, but for various reasons, not the least among which was the trouble of securing proper contacts at the relay and switch points for such low voltages, the voltage was gradually increased to the above mentioned figures.

Mr. A. H. Abbot of Chicago has recently given some interesting figures concerning the life of incandescent lamps in switchboard work, and mentions one case where a lamp was flashed over a million times without showing serious signs of deterioration. His tests seem to indicate that for general service in switchboard work the average lamp will live for a period of about 1200 hours, although in laboratory tests a much longer life has proved possible. He points out, as a result of his observations, that, according to theory, the lamps used in subscribers' line circuits should last about 25 years and those in the cord circuits used as "supervisory" and clearing-out lamps, for from one to two years. He also says that such a life has already been obtained in the cord circuit lamps, but that it is doubtful if the theoretical limit for the line lamps will ever be closely approximated.

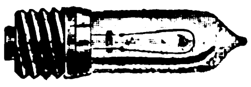


FIG. 3.—SIGNAL LAMP

LESSONS IN PRACTICAL ELECTRICITY

HOW TO DESIGN A DYNAMO.

We must now make some preliminary calculations to see whether or no the armature we have designed in the last section will overheat.

There are two sources of heat in an armature under load, viz., the core loss and the wire loss. The core loss, in turn, consists of two parts, that due to eddy currents and that due to hysteresis. The loss by eddy currents it is impossible to calculate. It depends upon the specific resistance of the metal, the degree of lamination of the core, the quality of insulation of the laminations, conditions which it is very hard to determine; and, even if they be known, the formulæ will be highly empirical. Fortunately, eddy current losses are usually slight.

Hysteresis, on the other hand, is very readily calculated by the aid of appropriate tables. These tables, which are to be found in many reference books, usually give the loss in watts, per cycle, per second, per cubic inch of iron, for the various densities of magnetization. We must, therefore, calculate the number of cubic inches of iron in the various parts of our armature and determine the magnetizations to which they are subjected. The teeth we already know to be substantially trapezoidal in section, with an altitude of 695.8 mils, and we can readily compute the average width, which we will find to be 211 mils. This gives a section of .1466 square ins. Multiplying this by 11, the length of the armature, we obtain the volume of one tooth, and by 42, we obtain 67.75, the volume of all the teeth in cubic inches. To find the maximum flux to which these teeth are subject it is necessary to compute the area of each tooth at the root. The dimensions, as we already know, are .1585 ins. wide by 11 ins. long. We must now assume a polar arc in order to find how many teeth are doing duty in carrying the flux. The poles are commonly supposed to cover two-thirds of the armature, the remaining one-third being split up into gaps between the pole tips. Therefore one-third of the teeth are carrying the total flux—that is, practically 14 teeth are carrying the total flux of 3,095,240. The effective area of the roots of the 14 teeth is 24.4 square ins., and hence the density is 126,500 lines per square inch. Referring to tables, we find that the number of watts lost per cycle per minute in a cubic inch of iron at that density is .00047.

We have 67.74 cubic ins. of iron, and as we are running at 1500 revolutions we have 1500 cycles per minute, the total watt loss due to hysteresis in the teeth is 67.74 × 1500 × .00047 = 47. 7 watts.

We now come to the hysteresis in the armature body proper. That was designed with iron area to carry 70,000 lines per square inch. The iron carrying this flux is a hollow cylinder about 5.1 ins. in external diameter by 1¼ ins. in internal diameter. Its volume is therefore, 211.3 cubic ins., and, applying similar methods, we find the loss in this part of the core to be 63.4 watts.

We now pass to the calculation of the wire loss. The length of each turn consists of a loop, the sides of which are each 11 ins. and the ends about 7½ ins. Although the armature is 6½ ins. in diameter, we must add a certain amount on account of overlapping of the ends. This makes the total length of loop 37 ins. We have 84 such loops, giving a total length of wire on the armature of (84 x 37) or 3108 ins. We selected in the first place No. 8 Brown & Sharpe wire, and the resistance of such a piece of wire, computed from the wire tables, is .163 ohms. The current circulating in this wire at full load is 27½ amps., and the loss in watts is obtained by squaring the current and multiplying by the resistance, and will be found to be 123.1 watts. We now must refer to practical experience, and that tells us that if the armature losses do not exceed one watt per square inch of radiating surface there is no danger of overheating. The armature consists of a cylinder, which in its completed state will be about 12 ins. long and 6½ ins. in diameter. The surface of such a cylinder is 312 sq. in., giving a radiation of about .75 watts per square inch. This shows that the armature is very suitably designed for its work; in fact, it would carry a substantial overload without trouble.

We must also remember that we have figured very liberally in making this calculation. We have, for instance, assumed for the total density throughout the teeth that at the narrowest section, which is not strictly the fact, and we have also figured the armature as a solid mass of iron, whereas it is made up of laminæ, and the assumption that it was solid erred perhaps within 5 or 6 per cent, according to the thickness of the insulation between the plates. It is, however, always best to figure in this way, for calculations on hysteresis loss are apt to be thrown many per cent astray, due to the fact that iron is not at all uniform in this respect. In fact, it may easily be that of two samples, apparently similar, one will consume twice as much energy as the other, when subject to a certain cycle of magnetization.

It is not the purpose of these lessons to take up mechanical points in design and construction, but simply to show how to determine magnetic and electrical dimensions. We may now summarize the following for our armature:

Core disc, external diameter	6½ ins.
Core disc, internal diameter	1¼ ins.
Number of slots	42
Width of slot	225.5 mils.
Depth of slot	695.8 mils.
Thickness of slot insulation	35 mils.
Size of armature wire	No. 8 Brown & Sharpe
Number of wires per slot	4
Total number of wires	168
Number of bars in commutator	42
Length of core	11 ins.

Before finally accepting this design we must make one more precautionary calculation, that of the peripheral speed. To do this we, of course, multiply the circumference in feet by the number of revolutions per minute, obtaining a peripheral speed of 2550 ft. per minute. A conductor velocity under 4000 feet per minute is permissible in such an armature, and hence we may regard the design as satisfactory and proceed to the field magnet calculation.

In calculating the field magnet we must first determine what material shall be used; something about its magnetic permeability, and similar matters. We must further determine what is known as the leakage coefficient. It is a fact that of all the lines generated in a field magnet frequently one-third, or sometimes as much as one-half, are lost in leakage; and the ratio of the total flux to the useful flux is known as the leakage coefficient.

There exist a great many empirical formulæ for calculating this leakage coefficient beforehand, and they are moderately reliable, though somewhat complicated in their application. A practical designer is usually well acquainted with the leakage coefficients of the various types of field magnet, which he is wont to adopt and can make a very shrewd guess as to what the average leakage coffiecient will be. Moreover, in designing a field magnet, a margin is always allowed for rheostatic control, and this margin ought to exceed any error in leakage coefficient determination. For the purpose of this article it is sufficient to select the leakage coefficient from the table of average values given in the August number. For a 5-k.w. machine this is 1.6. It therefore follows that we must generate in the field magnet 1.6 times the number of useful lines we use in the armature, which will amount to 4,952,384 lines of force. We will further assume that the field magnet be a steel casting, which can be comfortably worked at 90,000 lines to the square inch, without using excessive magnetizing power. The area of the field magnet waist must be therefore 55.02 sq. ins., and if we assume this area to be circular it will have a diameter of 8.36 ins. The next question is the length of this magnet waist.

From a theoretical point of view, this magnet waist should be just long enough to allow the requisite number of ampere turns to be wound upon it, for any added length increases the length of the magnetic circuit. Practically speaking, such a construction is a mistake, because it is frequently desirable to rewind the field magnet and frame for other voltages and capacities, and some flexibility in the size of the bobbin that may be put on is highly desirable. Moreover, the reduced length of the magnetic circuit, obtained by careful calculation, would only diminish its reluctance a very few per cent, and the gain in magnetizing energy would be almost microscopic.

We may take as a reasonable assumption, for the purposes of preliminary calculation, that the total reluctance of the magnetic circuit is equal to double the reluctance of the gap space. This proportion obtains in good dynamo design. The reluctance of the gap space has already been determined by our previous assumptions. Its area is practically equal to the area of the polar faces, and its length is the minimum length that mechanical conditions will permit, and may in this machine be as close as one-twentieth of an inch. If, therefore, we multiply the total number of lines of force by this length in inches and divide it by the area and multiply that result by .3132, a constant which transforms c.g.s. magnetizing force into ampere turns, and also takes into account English measures, we shall obtain the number of ampere turns necessary to force the flux through one of the gap spaces. As there are two gap spaces we must double this amount. The calculations are shown below:

$$\text{Area of pole piece} = \frac{6.5 \times 3.1416 \times 11}{3} = 75$$

$$\text{Ampere turns} = \frac{3{,}095{,}240 \times .05 \times .3131}{75} =$$

648 for one gap

Ampere turns both gaps = 1396.

If we take double the ampere turns necessary for the gap spaces we shall find the total ampere turns to be 3792, and we are ready to determine approximately the size of the shunt wire necessary to produce this magnetization, and from that to gain an idea of the size of the field coil.

It is to be understood that these calculations are preliminary, and, having thus obtained the dimensions, it will be necessary to review the latter carefully and modify them where they are objectionable. Such methods as this are frequently used in dynamo design, and in all other cases where results that are opposed to each other are desirable. Thus it is desirable to have low speed, small exciting current and minimum armature reaction. Low speed demands strong field and many armature conductors. Small armature reaction, on the other hand, requires few armature conductors, and strong field requires large exciting current. It will be necessary, therefore, to subsequently adjust these conflicting conditions to a happy medium.

Letters on Practical Subjects

Hardening Machine Tools.*

To the Editor of American Electrician:

Sir: There are two things of vital importance in hardening milling cutters or other tools that have to be hardened all over: First, heat evenly and not too hot; second, cool evenly and quickly. Do not try to heat the cutters in too small a fire. Build up a good big fire of charcoal, so that the cutters (or other articles) are surrounded on all sides by a mass of glowing coals of uniform temperature. A moderate natural draught is much to be preferred to a blower blast. If there is no natural draught it may be necessary to use the blower, but this should be done with the utmost caution, as it tends to make an intensely hot spot directly over the tuyere, surrounded by zones of successively lower temperature, which may render it impossible to do good work or even cause the work to crack when it is dipped. There is no advantage in heating very slowly; in fact, it is better for the steel not to keep it in the fire any longer than is necessary to bring it to the proper heat all over, without overheating any part.

When the cutter has reached the proper temperature for hardening (which varies somewhat with different brands of steel, most kinds requiring a cherry red, but some hardening at a blood red), it should be removed and dipped.

If it is bad to use a small fire, it is worse to use a little water. Do not try to harden a big cutter in a little pail of water. Have a tub made from half a whiskey barrel, at least. A whole barrel with one head removed is still better for large work, on account of the increased depth. Fill the tub or barrel with strong brine. The salt raises the boiling point, thereby increasing the cooling action.

Lift the cutter by means of a small rod with a hook bent on the end, inserted through the hole. Do not use a rod that fills the hole, as the brine should have free access to the interior. Hold the cutter over the center of the water and immerse by a quick but steady motion, perfectly straight down. Do not go in with a splash, and do not hesitate. Do not stop and hold the cutter still as soon as it is immersed, but lower it to the bottom, and then pull it up again. Keep it moving until it is cold.

A cutter of large diameter and small width, that is, disc shaped, should be immersed edgewise. If the axial dimension is considerable, that is, if the shape is cylindrical, the cutter should be immersed end first. Some prefer to finish the cooling in oil, as less liable to crack the work. As soon as the work has cooled sufficiently to become black on the outside, remove it from the brine and immerse in a tank of oil, keeping up a lively motion until it is cold.

When the cutter is cold, polish a few teeth with emery cloth so as to observe the colors in drawing the temper. Draw to a light straw color and cool off in water or oil. It is essential that the heat should be perfectly uniform. An excellent way to draw the temper of a cylindrical cutter is to put it on a red hot iron rod which nearly fills the hole held horizontally, and keep it turning slowly. Small cutters may be drawn in the gas, and large ones of any form drawn on a hot iron plate, turning them over and over all the time. They may also be drawn by direct exposure to the fire, but this requires much greater care to secure good results.

TOWNSEND WOLCOTT.

Some Electrical Sport.

I take the liberty to review for the edification of your readers two experiences which are along the line of the electrical sport which has appeared from time to time in your columns, and which may amuse your readers. It requires practical experience in such matters, however, to appreciate them fully. The first of these "jobs" entailed the doctoring of door knobs. Quite a number of the street urchins used to be in the habit of visiting the station. They would prowl around into every room and peek into cupboards where they had no business whatever. We could not watch them all the time, and to lock up every door proved so great a nuisance that it was abandoned.

Finally all the door knobs which were metallic concerns were connected up, having first been fitted with contact points so arranged that if the knobs be turned more than the stated distance in either direction a circuit would be closed which contained the intruder's body as a part thereof. By turning the knob just far enough to move the bolt contact would not be made, and doors and cupboards could be opened at will without danger or even discomfort.

An excellent magneto was in the station; this instrument was permanently connected up and driven by a belt which ran continuously. One side of the magneto was grounded, the cement floor of the station offering an excellent opportunity for the door knob business. Each knob and cupboard catch was then connected up as described. The result was that every street urchin received a severe shock, but none of them ever got a second one.

Another case of sport for the operator, but decidedly not for the victim, has just come to light in a town not 1000 miles from New York City. The day engineer of the station got into the habit of returning to his boarding house at very unseemly hours, very close to if not past midnight.

The worst of it was the exceeding slyness with which the engineer entered his boarding house. He was determined that no one should know when he came in or where he came from. To this end he always removed his shoes as soon as he entered the hall, and groping in the dark he would find the stairway and ascend with scarcely a sound.

One night the boys determined to know when the engineer came in and to permanently cure him of his nocturnal proclivities. To this end a little wiring was done on the sly around stairway and hall. A door at the foot of the stairs opened outward into the hall. This was used in place of a switch, and a half dozen incandescent lamps were hung on the stairs and in the hall and connected up so that opening the door would turn on the current.

Two or three electric door mats were borrowed from an adjoining drug store and placed in the hall and connected with bells in the rooms occupied by the would-be jokers. Screw eyes were inserted into the base boards on either side of the hall and a dozen lengths of string were tied across 6 ins. from the floor, or just about ankle high.

A bushel basket was filled with old tomato cans and balanced on top of the stairs so that the least touch would precipitate it rattling down into the hall below. A string made connection between the closed doors and the basket handle. To make the matter still more interesting, half a dozen sheets of tangle foot fly paper were procured and cut into two pieces each. These pieces were scientifically distributed along the hallway on the floor.

At just about 12:02 that night a terrific ringing of bells woke everybody in the house. Simultaneously with the ringing came a flash of light in the hallway and on the stairs a crash of a heavy body falling into the hall, then after a brief interval a few half-smothered swear words came up stairs and the basket of tins went down to meet them.

By this time everybody had reached the stairway, and there at the bottom on his hands and knees was the engineer. His hands, feet and head were ornamented with sticky fly paper, and the tableau was ludicrous in the extreme. I will not discuss it further. It can easily be imagined.

L. S. Carson.

The Resistance of Magnets.

To the Editor of American Electrician:

Sir—I note a query from C. M. in the July "Electrician," asking what the resistance of nineteen magnets should be to work in series with twenty-five dry batteries, and would reply as follows: I assume that the working conditions of the magnets are for maximum effect, therefore the resistance of the magnets should be equal to the internal resistance of the batteries. For simplicity, the line resistances will be assumed zero. The electrical dimensions of a dry cell vary, but a safe assumption is 2 ohms and 1.5 volts. We then have the following:

$$\frac{25 \times 2}{19} = 2.631,$$

which is the resistance in ohms of each magnet. The current flowing under the above conditions will be:

$$C = \frac{Ne}{NR + r} = \frac{25 \times 1.5}{25 \times 2 + 19 \times 2.631} = .375$$

amps. In this case N equals the number of batteries. No. 25 B. & S. gage is a very convenient size for magnet winding, providing the magnets are not too large. Each magnet will contain 7281.2 ft., the temperature being assumed to be 75 degs. F. The nineteen magnets will contain 11.5 lbs.

Jas. T. Jennings.

ELECTRICA CATECHIS

236. What is the general principle upon which electromagnetic instruments are based?

Electromagnetic instruments, which include nearly all ammeters and voltmeters, depend upon the fact that every current is surrounded by a magnetic field which reacts against any other magnetic force in the same field. This is illustrated by Fig. 1, which shows the effect of a wire carrying a current through the field of a magnet. The lines of force, which formerly went from one pole to the other by straight lines or short curved ones, as shown in Fig. 2, now are stretched by the effect of the current, and the wire must move in toward the magnet poles in order to relieve the tension. In the figure the current is shown as going down or into the paper; if the direction of the current had been opposite, the current would have been repelled, since the lines of force would then have been crowded together closer on the inside toward the magnet.

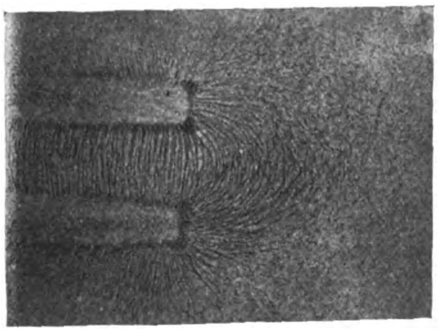


FIG. 1.—FIELD OF FORCE.

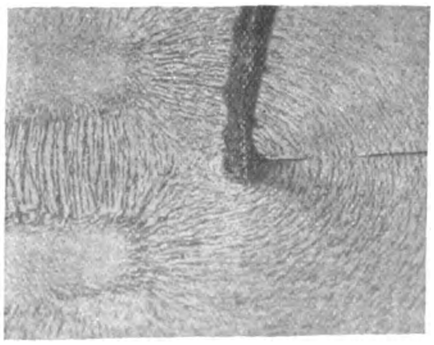


FIG. 2.—DISTORTED FIELD OF FORCE.

237. Does the whole current pass through the coil in an ammeter of the d'Arsonval type?

Only in those for very small currents. In order to be sensitive, the hair springs must be small and not be allowed to carry much current, or they may get hot enough to lose their temper. A voltmeter takes so little current that the whole of it can safely pass through the delicate hairsprings without danger, but only a small fraction of the current through an ammeter can pass through the springs.

238. How can the ammeter be made to measure correctly when only part of the current goes through the coil?

The coil is arranged so that a definite proportion of the whole current passes through it. A large conductor of low resistance is connected directly between the two terminals or binding posts of the instrument; the coil is connected as a shunt around a definite part of this main conductor; then, since the two are connected in multiple and each branch has a definite resistance, the current divides between the two branches directly in proportion to their relative conductivity, or inversely, according to their resistances. The coil, therefore, takes a definite part of the whole current, and the force moving it and its pointer away from the zero position is directly proportional to the whole current.

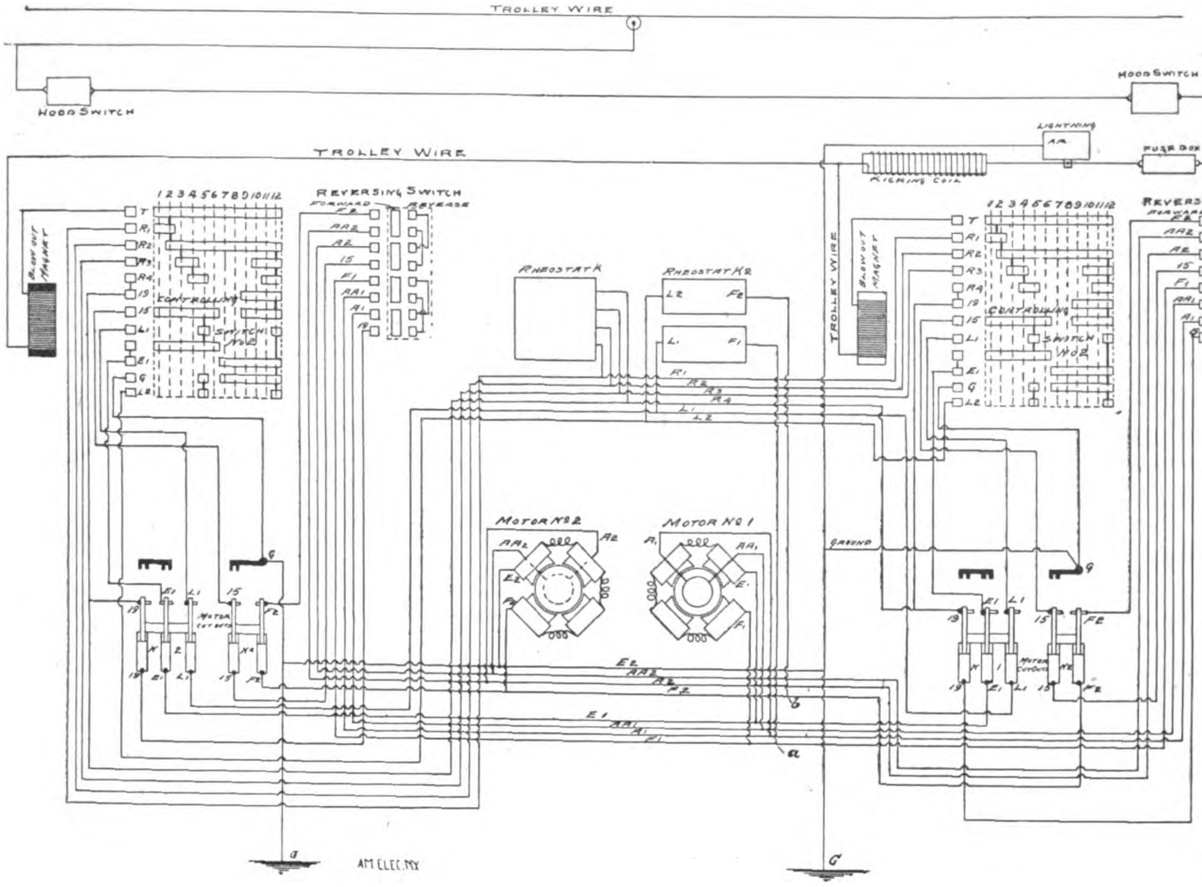
239. What is the construction of the Weston switchboard ammeters, in which the instrument is connected only by small cords like lamp cords?

In these instruments, as with all their instruments for very large currents, the "shunt" is arranged for connecting directly into the bus bars, while the rest of the instrument may be placed wherever desired. The part usually thought of as the instrument is really a d'Arsonval galvanometer, practically the same thing as the voltmeter, and contains a permanent magnet with a coil mounted on pivot bearings and controlled by hair springs, which also carry the current into the coil. The coil with its hair springs and the connecting cords have a definite resistance; when these are carefully connected to the "shunt" in the bus bars, a small but definite portion of the whole current goes through the cords and the galvanometer, which thus measures the whole current.

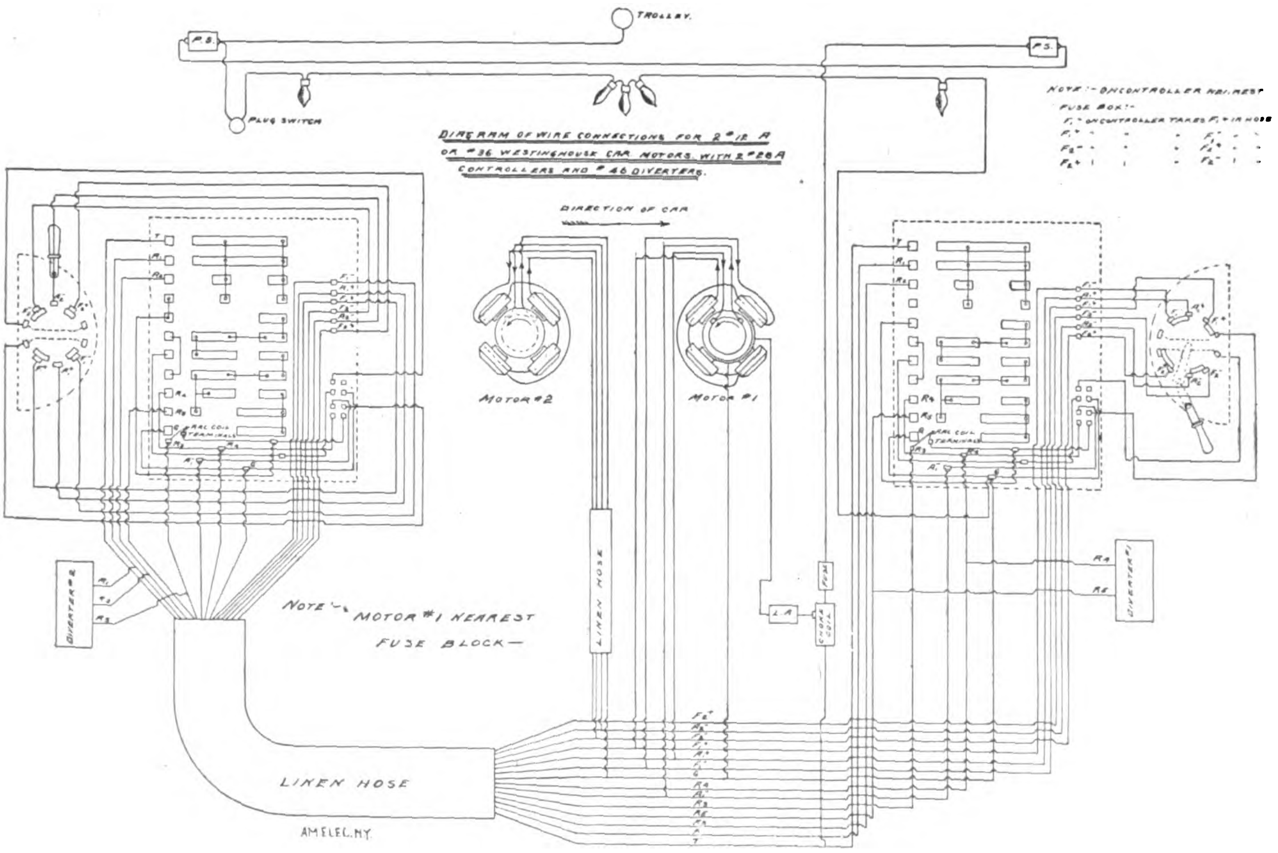
240. What advantage is there in this kind of instrument?

It saves considerable expense in building the switchboard, since the bus bars do not have to be carried to any particular place to suit the instrument. Also if desired, a number of galvanometers may be connected around the shunt, so that the current may be read from different points. It is also possible to do away with the regular shunt entirely and connect the galvanometer cords to points on the bus bars themselves (which points must be found with care), and so do away with the two joints in the bus bars otherwise necessary. It is also possible to use the same galvanometer for measuring the currents in several different circuits.

CONTROLLER CONNECTIONS.

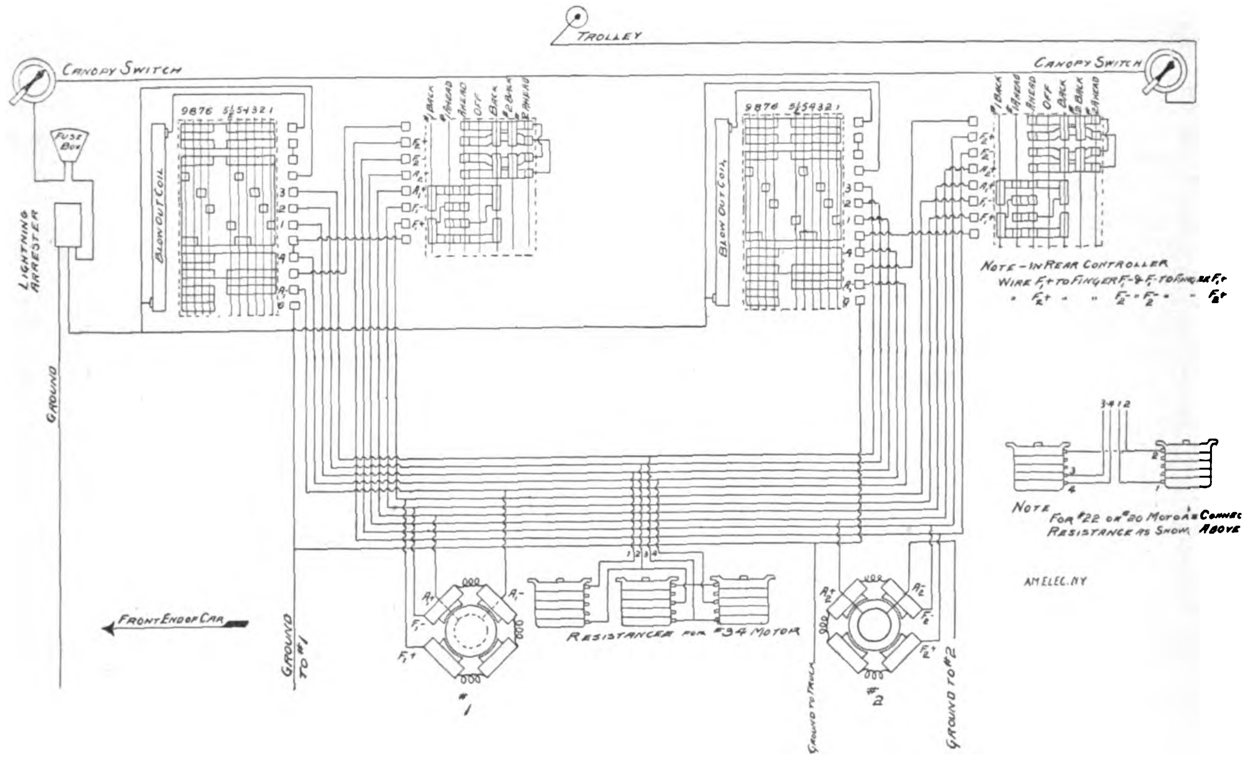

TROLLEY WIRE
HOOD SWITCH
HOOD SWITCH
TROLLEY WIRE
LIGHTNING A.A.
FUSE BOX
KICKING COIL
BLOW OUT MAGNET
1 2 3 4 5 6 7 8 9 10 11 12
T
R1
R2
R3
R4
19
15
L1
E1
G
L2
CONTROLLING SWITCH No 2
REVERSING SWITCH
FORWARD
REVERSE
F2
AA2
A2
15
F1
AA1
A1
19
RHEOSTAT K
RHEOSTAT K2
L2
F2
L1
F1
R1
R2
R3
R4
L1
L2
TROLLEY WIRE
BLOW OUT MAGNET
MOTOR No 2
MOTOR No 1
AA2
A2
A1
AA1
E2
E1
F2
F1
GROUND
G
MOTOR CUT OUTS
E2
AA2
A2
F2
E1
AA1
A1
F1
b
a
a
G
AM ELEC NY

General Electric Company K_2.

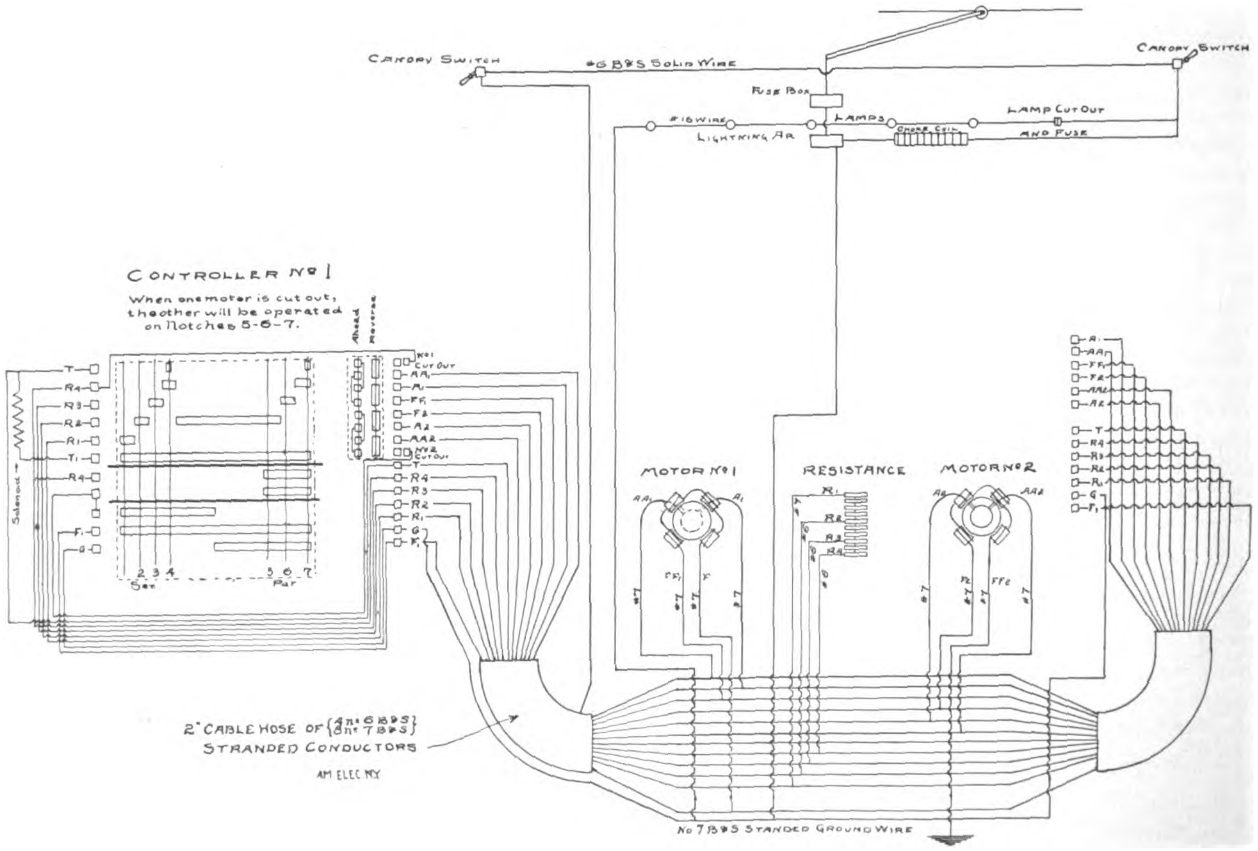

TROLLEY.
F.S.
F.S.
PLUG SWITCH
DIAGRAM OF WIRE CONNECTIONS FOR 2 #12 A OR #36 WESTINGHOUSE CAR MOTORS WITH 2 #28 A CONTROLLERS AND #46 DIVERTERS.
NOTE:- ON CONTROLLER NO.1 NEAREST FUSE BOX:-
F1- ON CONTROLLER TAKES F1+ IN HOSE
F1+ " " " F1- " "
F2- " " " F2+ " "
F2+ " " " F2- " "
DIRECTION OF CAR
MOTOR #2
MOTOR #1
DIVERTER #2
DIVERTER #1
LIKEN HOSE
L.A.
F.S.
CHOKE COIL
NOTE:- MOTOR #1 NEAREST FUSE BLOCK—
LIKEN HOSE
AM ELEC. NY

Westinghouse Electric and Mfg. Co. 12A.

CONTROLLER CONNECTIONS.


Trolley
Canopy Switch
Canopy Switch
Fuse Box
Lightning Arrester
Ground
Blow Out Coil
Blow Out Coil
9876 5 54321
Back
Ahead
Off
Back
Ahead
Note – In Rear Controller Wire F1+ to Finger F1- & F1- to Finger F1+
" F2+ " " F2- " F2- " " F2+
3 4 1 2
Note For #22 or #20 Motors Connect Resistance as Show Above
AM ELEC. NY
Front End of Car
Ground to #1
Resistance for #34 Motor
Ground to Truck
Ground to #2
#1
#2

Walker Company Type S.


Canopy Switch
#6 B&S Solid Wire
Canopy Switch
Fuse Box
#16 Wire
Lamps
Choke Coil
Lamp Cut Out and Fuse
Lightning Ar.
Controller No 1
When one motor is cut out, the other will be operated on Notches 5-6-7.
Ahead
Reverse
Solenoid
Ser
Par
No 1 Cut Out
No 2 Cut Out
Motor No 1
Resistance
Motor No 2
2" Cable Hose of {4 No 6 B&S / 8 No 7 B&S} Stranded Conductors
AM ELEC NY
No 7 B&S Standed Ground Wire

Johnson Company "Steel" Motor.

QUERIES AND ANSWERS

Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied. The privilege of this department only extends to subscribers, and queries must be accompanied by name and address to secure attention.

How is it that the shifting of the brushes on a closed coil machine increases and decreases the number of active conductors in the armature?

The field magnet of the machine divides the armature into bands of conductors having e.m.fs. in the same direction. If the brushes are placed to commutate on these division marks between these different bands of common direction the current in the wires will agree with the e.m.fs. and the number of effective conductors will be a maximum. If, however, the brushes are shifted to some other position, the current which traverses the armature will flow through some of the conductors whose e.m.fs. are opposed to the direction of the main current. This diminishes the total effective e.m.f. in proportion to the magnitude of the e.m.f. in the conductors thus cut out of position.

Can an efficient accumulator per pound weight be made with sheet lead plates, the surfaces of which have been roughened by hammering with a coarse file; the plates to be coated with litharge paste and enveloped in three thicknesses of cheese cloth, the bundle of plates being loosely bound together with rubber bands? R. E. K.

The construction you describe is a common one used in making amateur storage cells. The internal resistance is rather high, thus making the weight efficiency low, and, moreover, it is not of a very permanent character. The paste for the positive plates should be made from peroxide of lead, Pb_3O_4, not litharge, the symbol of which is PBO. Litharge may be used for the negative plates. The paste may be made by wetting up the peroxide with a solution of very dilute acid. It is not very adhesive and must be secured in place by some means such as you have described.

1. Is chemically pure sal ammoniac better to use in batteries, both dry and liquid, than commercial, or is it different in its use from commercial NH_4Cl?

2. Are carbons made for electric light purposes as good for battery use as regular carbon plates. H. B.

1. The difference, if any, is not worth the added cost of the pure sal ammoniac. Lump sal ammoniac, such as is used for soldering, contains iron and should be avoided.

2. The electric light carbons are a little soft, but will answer for battery purposes, provided their copper coating is removed by treatment with dilute nitric acid.

1. Is ozone produced by direct or alternating current?

2. When decomposing water by current, and thus producing ozone, will water heat to more than 140 degs. F.? W. P. S.

1. Ozone is produced by electrostatic discharge, which is of an oscillatory character. Neither alternating or direct currents of ordinary commercial voltages will answer; the discharge should be produced by a static machine or induction coil.

2. When decomposing water ozone is not produced, but oxygen and hydrogen are produced, one at either pole. If sufficient current is passed through the water it may be heated to the boiling point, 212 degs. F., but can get no hotter.

What is the best way to permanently magnetize steel? A. K.

Heat the steel to cherry redness in a strong magnetic field and harden it glass hard by raising a bath of water or oil up around the steel, not removing it from the magnetic field. The steel needs to be carefully selected and some of the approved brands of imported steel are said to be the best.

In the February and March issues of the "American Electrician" is an article on designing small motors, by Cecil P. Poole. In the issue of February, 1898, is tabulated the following:

		Density.	Total length of path.	Ampere turns.
Air-gap..............	$\frac{77,000}{5 \text{ ins.}} =$	15,000	⅛ in.	603
Pole pieces (cast)...	$\frac{97,000}{5 \text{ ins.}} =$	19,400	3 "	21
Field cores..........	$\frac{107,800}{1.48} =$	72,838	6 "	98
Yoke (wrought iron)	$\frac{90,000}{1.25} =$	72,000	3¾ "	57

1. What does the 5 ins. in the fraction in the first two lines mean, and where is it measured, and the decimal 1.48 and 1.25 in the third and fourth, respectively? How is the 3-in. length of path in the pole pieces and the 3¾ in. in the yoke measured?

2. What kind of primary battery would you recommend for a 1-6 h.p. motor to deliver about 6 volts?

1. The explanation of the fractions is as follows:

Total flux....	77,000	97,000	107,800
Area of path.	5 sq. ins.	5 sq. ins.	1.48 sq. ins., etc.

The area of the path is measured, of course, at right angles to the direction in which the magnetic lines are supposed to flow. The 3 ins. length of path in pole pieces is measured from the curved surface of one pole piece to where the core takes the flux, and doubled, there being two pole pieces. The length of path in the yoke is from center to center of the cores if they are butted to the yoke; when they are set in the yoke the length of the path in the latter should be measured from edge to edge of the cores.

2. For intermittent service some type of bi-chromate battery is best. For constant service something on the Bunsen or Grove style will answer. It will require four or more cells in series, according to the size of the cells and the efficiency of the motor.

What is the resonance in a line or transformer, and what causes it? A. W. B.

In every electrical circuit there is a certain frequency of alternation, which produces an effect known as electrical resonance. It is a function of the inductance and capacity of the circuit. If these are adjusted in a certain way the result will be an enormous rush of current, which usually produces disastrous results. It is akin to acoustic resonance, in which a tube or pipe will take up a certain vibration and respond with a volume of sound, but will be silent to other vibrations of slightly different frequency.

I have some transformers—1000-volt primary and 30-volt secondary—and I wish to change the secondary voltage to 100. What would be the necessary change in winding? Would the same iron core answer? F. B. H.

The same iron core will do. Remove the secondary and carefully count the number of turns as they are unwound. Rewind with a wire of 1/3 the size in circular millage, and using 3 1/3 times as many turns.

1. Are any of the fan motors used on alternating currents shunt and series wound? If so, can they be used on direct currents?

2. Can such motors be used on any number of alternations?

3. Can an induction motor run on single phase circuit?

4. If small shunt and series motors run on alternating current, why are not larger machines of this class run with it?

5. I have a direct current 10-h.p. motor loaded to its capacity. If I decrease the field strength to make it run faster, will it give as much power or will it give more?

1. Some alternating current fan motors are simply series motors. The shunt motor is not applicable because the current in the field magnets would not be in phase with the current in the armature. They will run with direct currents, if supplied at the proper voltage.

2. Such motors are to an extent independent of frequency, but there is a certain frequency at which they will operate best.

3. An induction motor can be run on a single phase circuit, when once up to synchronism, but it requires some extraneous means of starting. The monocyclic motor is practically a single phase induction motor with a polyphase winding for use on starting.

4. Series motors are very unsatisfactory on alternating current circuits, as they produce a heavy inductive load, and are therefore permissible only in small sizes.

5. If you reduce the strength of the field of your motor it will run faster, provided you do not reduce it too much. It will give out more power, but it will call for more current to do this and may burn out your armature.

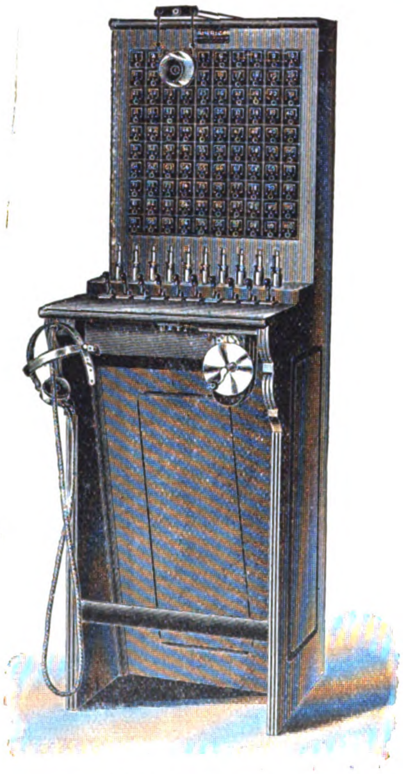
What is a suitable material to be used for a making and breaking contact in a mercury cup? We use a copper wire, which is very quickly eaten away by the mercury. R. R.

If there is considerable current to handle and the circuit is frequently broken, almost any wire will be gradually consumed. Aluminum and iron, however, are practically unaffected by mercury, and either could be profitably used.

New Apparatus and Appliances.

A COMPACT EXPRESS SWITCHBOARD.

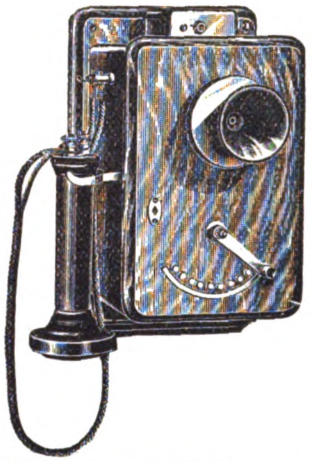
The accompanying cut shows a 100-drop express switchboard of the American Electric Telephone Company, Chicago, which is wonderfully compact and efficient. The details of the drop and jack were explained in a technical article by Mr. Kempster B. Miller in the August issue of this paper. This board is built for metallic lines, is built with self-contained jacks and drops. The drops are mechanically restored by the plugs. There are no drops in the cords, the ringing off being effected through the main drops, which are restored on pulling out the plugs as well as upon pushing them in. Ringing cams are also dispensed with, the ringing being accomplished by pushing the plug in the jack deeper than its normal position. Among the interesting features of this board is the mounting of the combined jacks and drops, each set being entirely self-contained and constituting a small draw, which is removable from the front of the board and is firmly fastened in place on the back of the board by screws and nuts. These nuts make the line contact and the connected line wires are soldered to lugs, but it is not necessary to unsolder them in order to permit of the removal of the jack. Another board made by the same company, known as the "Universal" board, is also finding favor. This has the jacks in a separate panel over the drops, the latter being restored manually by means of a common drop-lifter. This company is using the Burns two-pole receiver with double-area gaps on all their instruments, and a solid-backed microphone with carbon gap and carbon plate.



EXPRESS SWITCHBOARD.

AN INTER-COMMUNICATING TELEPHONE SWITCH.

The chief drawback to the universal use of warehouse telephones in business houses, factories, schools and similar institutions has been due to the lack of proper means for obtaining connections between the different stations and restoring them without the aid of a central office, which, when comparatively few instruments are employed, is costly to maintain and requires constant attention. The ordinary manual switch has been used, but after making connection with it, it is necessary to return it by hand to its home point so that the instrument will be in proper position to receive and answer the next call. It has proved to be the case that people will neglect to turn this switch back, and no device has seemed to be able to cause them to properly restore the connections, and the result is a most unsatisfactory service. The switch herewith illustrated is designed to overcome the difficulty. It is operated the same as an ordinary switch, being turned around until the lever rests upon a point corresponding to the instrument desired. A slight pressure upon the knob of the switch rings up the instrument wanted without calling any of the others, and when the conversation is finished, the hanging up of the receiver automatically restores the switch lever to its normal position. The device is very thoroughly made. The working parts are made of case-hardened tool steel, and the workmanship is excellent throughout. It is covered by broad patents and manufactured in different forms for both wall and desk use, by the Holzer-Cabot Electric Company, of Brookline, Mass.

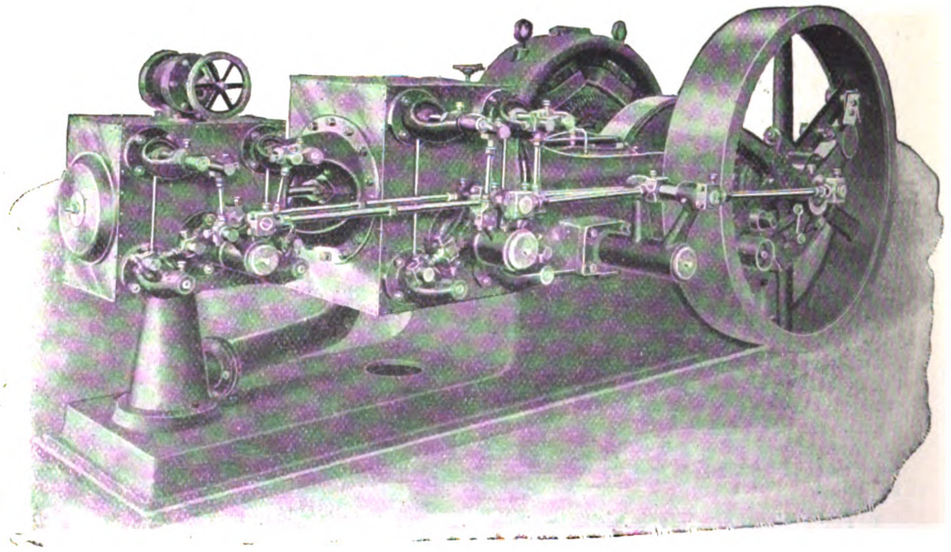


SELF-RESTORING TELEPHONE SWITCH.

A NEW CORLISS ENGINE.

We illustrate herewith the new horizontal tandem compound engine designed and built by the Ball & Wood Company, of New York. It is believed that in this engine are embodied all the best features of the well known Corliss type, together with a number of important and interesting improvements designed by the engineers of the Ball & Wood Company, with the object of obtaining the best possible distribution of steam, close regulation and high efficiency.

The valve gear is generally Corliss in type, but is without the usual Corliss tripping devices or dash pots. Instead of this the admission valves are operated by an independent wrist plate. The exhaust valves are actuated by a second wrist plate by means of an adjustable eccentric, and both wrist plates are connected by the Ball & Wood inertia governor, which is well known to be one upon which extremely small variations of speed have an immediate corrective effect. The valves are multiported on both steam and exhaust cylinders, thus insuring quick and full admission of steam into the cylinders and prompt release at completion of stroke. The exhaust motion is very rapid, and by means of the independent eccentric any desired adjustment is obtainable. The steam valves have large openings, and being operated



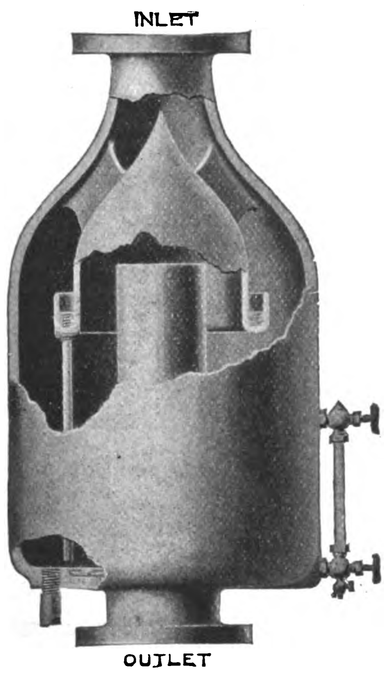
A NEW CORLISS ENGINE.

by the Corliss plate quick angular motion is obtained.

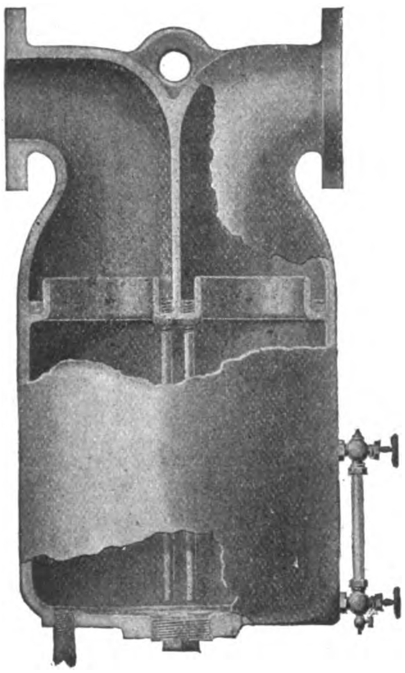
It is evident that the economy of this type of engine should be exceedingly good, and its regulation as nearly perfect as is possible to attain in engine practice. These new engines are manufactured in large and small sizes, for railway and lighting service, and in connection with the vertical and other types built by the company enable the latter to furnish to customers practically any type of engine desired.

A NEW STEAM SEPARATOR AND OIL ELIMINATOR.

In the accompanying cuts are shown two types of a steam separator and oil eliminator, which have recently been put upon the market. It is believed that their design is entirely new. In previous designs an effort has been made to cause the steam to take on a centrifugal, zigzag, or similar tortuous motion in its passage through the separator, and cause the entrained oil and water to be thrown off by centrifugal force. In the separators shown in the cut the object is to reduce the obstructions to the flow of the steam. In both of the separators shown the steam inlet gradually enlarges into a chamber, which is ten times the area of the pipe, and the outlet is gradually reduced to the original area. The entrainment is intercepted by gutters, which are kept partially filled with water. It has been found that these gutters, so filled, very effectively cut off the entrained water or oil, the channels being so arranged as to guard both inlet and outlet of the separator. In the vertical separator the steam enters the top; the entrainment follows the interior surface and will pass along that surface to the bottom of the separator, where it will be intercepted by the water at the bottom. Any water or oil in the steam which escapes the separation will strike the exterior of the cone at the top, and, spreading over this surface, will be caught by a gutter at the bottom of the cone and carried off by pipes provided for that purpose. In the horizontal separator, the steam may enter at either side, as both are alike. In its path through the separator it passes by two gutters which effectively catch the entrainment and carry it down to the bottom of the separator, where it is trapped off in the usual manner. All the separators for pipes above 8 ins. are built of flanged steel. They are manufactured by the Hoppes Manufacturing Company, Springfield, Ohio.



VERTICAL SEPARATOR.


HORIZONTAL SEPARATOR.

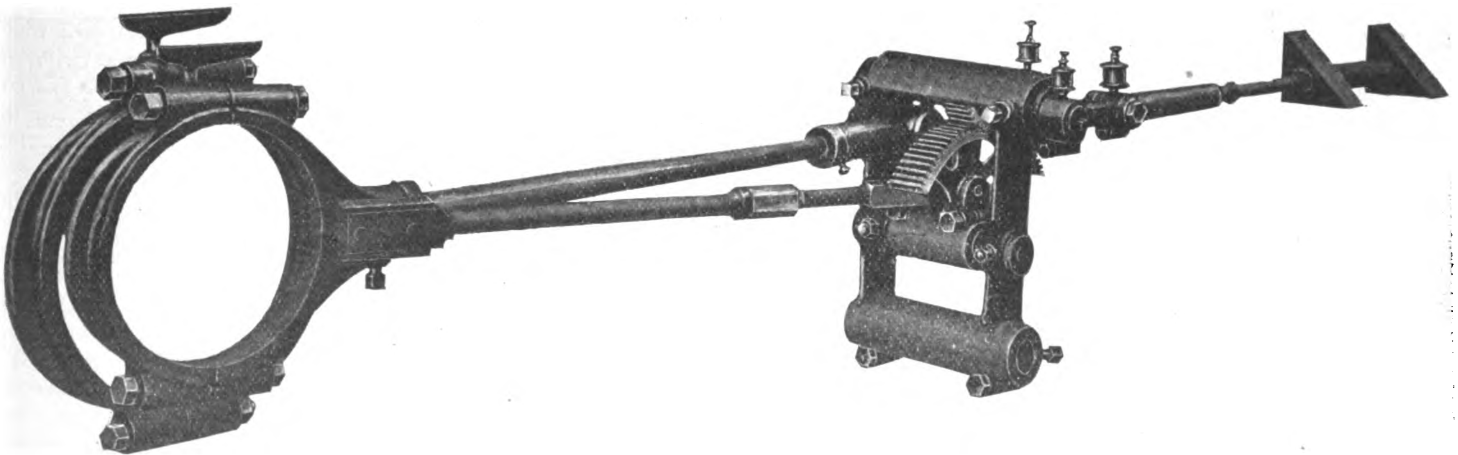
AN INGENIOUS VALVE GEAR.

The problem of properly distributing steam to either end of an engine cylinder by means of a simple valve gear has received a great deal of attention from engineers and manufacturers. It has generally been admitted that a simple eccentric motion cannot achieve the best results. The Corliss valve gear and its modifications does reach this desirable steam distribution, but at the expense of considerable complication.

In the accompanying illustration is shown a device for obtaining superior steam distribution with a single balanced valve.

This one valve performs the function of four separate valves by employing means to impart to it an intermittent motion, giving the valve a very high speed at the opening and closing of the port, and a lower speed during expansion. The valve opens rapidly and then moves slowly until the point of cut-off is reached; a quick movement then closes the admission port. This action gives the steam free admission and a level admission or steam line, and by its quick closing avoids wire drawing and secures all the advantages of the sharp cut-off. This mechanism also enables the exhaust to be opened promptly at the extreme end of the stroke, thereby allowing the steam to remain in the cylinder and expand to its fullest extent, giving unusual freedom of exhaust and avoiding undue compression.

The mechanism employed to produce these movements provides the ordinary automatic governor connected by the usual eccentric rod to the rocker arm or valve cross-head. In the upper end of the rocker arm is an eccentric shaft carrying a pinion; in mesh with this pinion is a toothed sector, which is also pivoted on the rocker arm, and is actuated by a fixed eccentric on the main shaft. The geared eccentric shaft carried by the rocker arm is connected to the valve stem by a simple connecting rod. The fixed eccentric is set nearly opposite but slightly in advance of the governor eccentric, that is to say, it

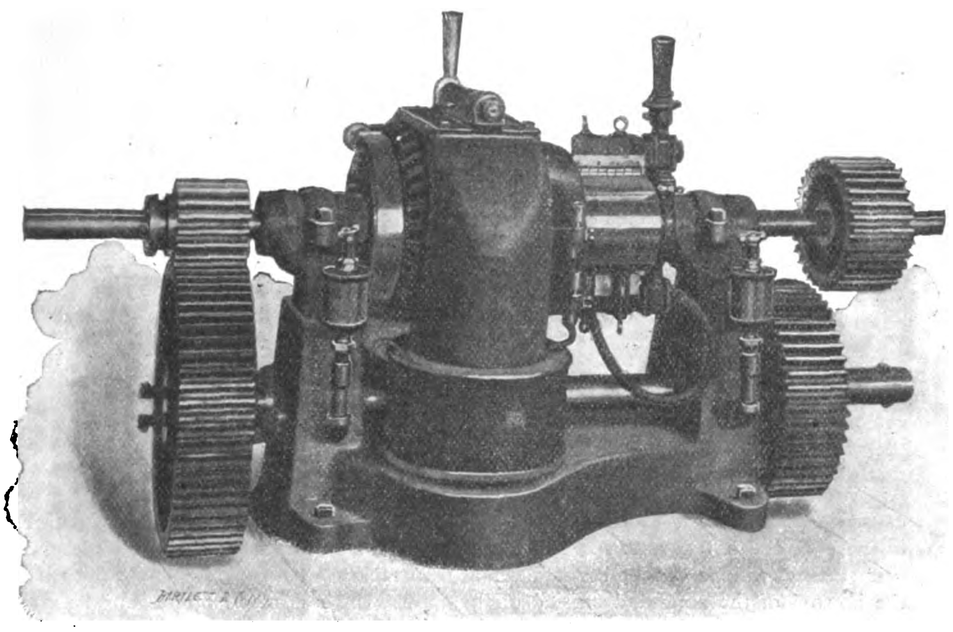

AN INGENIOUS VALVE GEAR.

is given a few degs. lead ahead of 180 degs. The sector will, therefore, move in one direction while the rocker arm moves in the opposite direction, thereby imparting through the pinion an oscillating motion to the eccentric shaft, giving the latter at shortest travel a little less than one revolution and at greatest travel a little more than one revolution. When the eccentric shaft is on either center the valve is in position of admission, and the movement of the latter will be due to the rocker arm and augmented by the rotation of the eccentric shaft in the same direction. At the completion of the stroke the return is similar, closing the valve by the time the eccentric shaft has returned to its center. During the next half revolution of the eccentric shaft its motion is opposed to that of the rocker arm and the valve's movement is retarded. The two movements are so timed that the valve comes practically to a standstill until at a predetermined point in the stroke the valve travel is accelerated, closing the exhaust in time for the desired compression, releasing at the opposite end and again admitting steam. The results are said to be equal to those obtained by the Corliss valve gear and to exceed the results accomplished by four valve types which do not use the detaching gear. It may be run on engines as high as 300 r.p.m., which is a decided advantage, as the limit for Corliss valve gears is about 100 r.p.m. As a result of the higher speed at which this valve gear may be operated the cylinder may be made shorter, thus increasing the number of admissions and obtaining thereby a higher cylinder temperature. By avoiding one set of ports a much reduced clearance is obtained, and by a much later compression together with higher initial and a later release, the economic results would appear evident.

Patents are being taken out on this movement in the United States and all the advanced foreign countries of the world by Mr. J. B. Allfree, and it is now being applied on engines built by the J. B. Allfree Manufacturing Company, of Indianapolis, Ind., who will take pleasure in giving any further information concerning it.

AN IMPROVED BRAKE MOTOR.

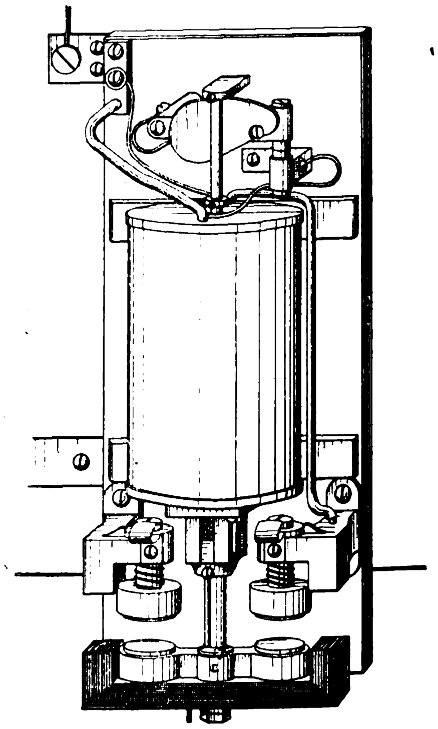
The accompanying illustration shows a comparatively new device, consisting of an electric motor provided with a braking attachment, which becomes operative the moment the current is shut off and quickly brings the motor to a stand-still. These motors are very useful and applicable to almost all machinery where prompt and accurate control is required, for example: Elevators and hoists, where it is important to provide adequate means for holding the load when hoisting; and also printing machinery and other devices where it is important to secure an instantaneous stoppage, without waiting for the machine to slow down. Heretofore, motors have been provided with separate means for doing this which are very cumbersome and require additional levers to operate the brake. In the motor shown the brake is arranged to grip the armature firmly as soon as the current is cut off. This motor is made in two forms. The standard motor has a single brake, which grips more strongly when the armature is revolving in the standard direction. This is sufficient for most requirements, but in addition a reversible form is provided, which grips the armature equally well with either direction of rotation. Most motors drive machinery of moderate speed: to do this gearing is required to supply the desired reduction. These motors are supplied with counter shafts arranged in their bases, and in the cut shown the motor has two sets of gears whereby two sets of speed may be obtained by throwing either the one or the other into operation. These motors are made by Crocker-Wheeler Electric Company of New York.



AN IMPROVED BRAKE MOTOR.

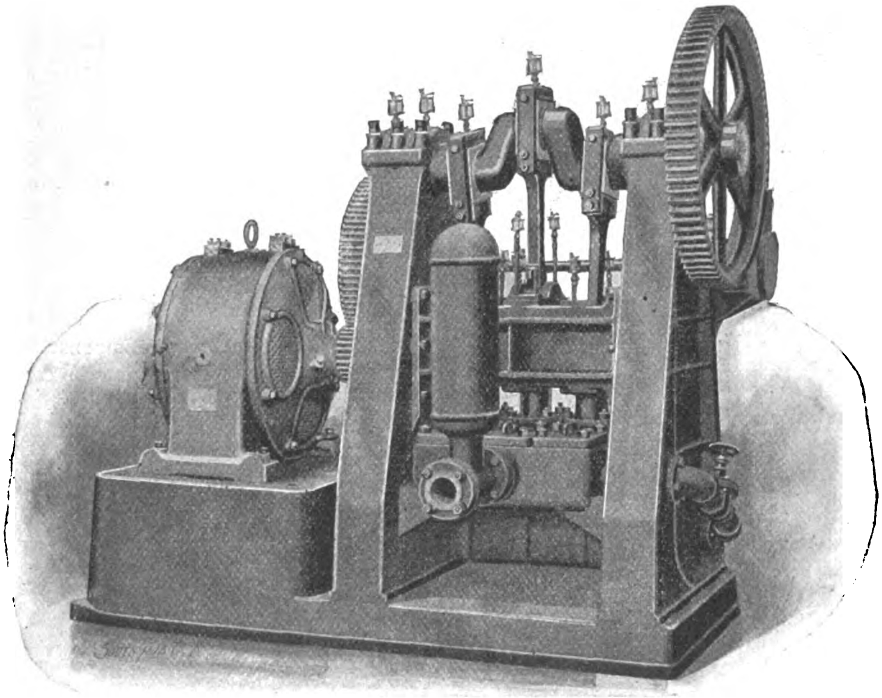
A NEW SECTIONAL RAIL SWITCH.

The accompanying illustration depicts a new automatic switch, which is to be used by the Safety Third Rail Electric Company of New York for heavy traffic. Their system, it will be remembered, has created a great deal of comment among electric railway men, as being one of the few sectional conductor systems which gives bright promise of success. The switch depicted in the illustration has been designed with reference to its current carrying capacity. The lower rectangular jaws are of laminated copper and can readily carry 300 amperes, while their momentary current-carrying capacity is undoubtedly between 600 and 700 amperes. These copper jaws are supplemented with carbon breaks, which successfully withstand the deflagrating action of any arc that might occur there. It is to be added, however, that the system of the Safety Third Rail Electric Company is such that no arcs occur at the switch jaws of the automatic circuit closers. This is accomplished by having one of the coils which acts on the plunger in series with the switch. It therefore follows that this coil will not allow the switch to open until the current in it has ceased, when the switch will fall open for lack of magnetic power to hold it up. At such times as this, however, there being no current to break, there can be no arc. When it is remembered that this difficulty of arcing is what has blasted the hopes of many a surface contact electric railway system and rendered it inoperative, this ingenious way for avoiding the trouble will be greatly appreciated. The action of the switch can be briefly reviewed in a paragraph. An iron-clad solenoid carries two bobbins wound on the same spool. One is a fine wire bobbin, which connects with the sectional rail and also with the ground through circuit breaking contact on the top of the switch. The other connects with the sectional rail through the switch



SECTIONAL RAIL SWITCH.

jaws to the feeder main. As gravity holds the switch open at times when the latter is inoperative no current can escape from the feeder main to the section, which is therefore insulated. When the car approaches the collecting trolley impinges upon the sectional third rail and immediately sends a current through the fine wire bobbin to ground. The plunger rises, closing the lower and breaking the upper circuit. The fine wire circuit is now open, but, as the motor is drawing current from the coarse wire circuit, the switch holds up and remains closed until the car has ceased to draw current from that section, when gravity pulls it open again. The switch is remarkably compact and requires only three electrical connections to the system. Two of these are made by simply screwing the switch against the bus bars in the switch vault, and the third, a light connection of flexible wire, is screwed into an appropriate binding post. The method of the whole installation is so obvious and simple that the ordinary laborer can hardly go astray. The Safety Third Rail Electric Company have offices in the Temple Court Building on Beekman Street, and have been very active in developing their system. They will doubtless be frequently and favorably heard from in the near future.



TESLA MOTOR AND TRIPLEX PUMP.

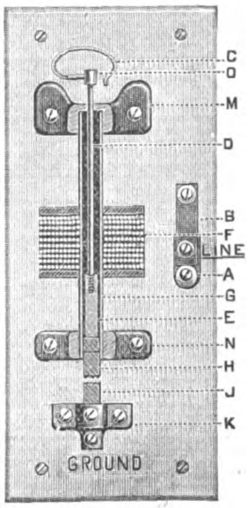
THE INCREASING USE OF ALTERNATE CURRENT MOTORS.

The prejudice against the alternating current motor is becoming historical, and it is interesting to note that this motor has now demonstrated its superiority over its direct current rival in a number of peculiarly trying applications. Among the original promoters of the use of alternating apparatus, the Westinghouse Company have been pre-eminent, whether in monophase or polyphase systems, and their Tesla Type C induction motor is universally admitted to represent one of the highest developments of the art. The motor has been frequently described in these columns, and the essential feature—that is to say, the absence of any connections between the line and the rotating parts—is familiar to every electrical engineer. These motors have shown their fitness for a peculiar line of service in an extensive installation at the factories of the Silver Springs Bleaching and Drying Company, of Providence, R. I. This company has been a pioneer in the use of electrical apparatus for mill purposes, and very early in the history of the industry purchased two direct current dynamos, which were used for lighting and power service until 1895. At this time the necessity for extensions induced the company to investigate the more modern developments in lighting and power service; and, after a most thorough investigation, Mr. E. C. Myrick, the company's engineer, recommended the adoption of the Westinghouse three-phase system, at 3000 alternations per minute for both lighting and power. This decision was at the time the subject of severe criticism by contemporary mill engineers, but the results of two years of active service, under the worst imaginable conditions, have demonstrated the soundness of the engineering judgment.

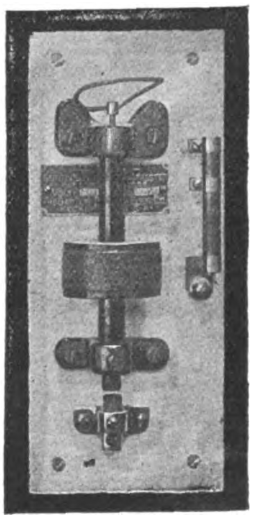
In addition to lighting the entire plant, some thirty Westinghouse induction motors, of from 3 to 75 h.p. have been installed. These motors are ample for driving the washing machines, ironing machines, triplex pumps, elevators, ventilating fans and similar contrivances. Some of the motors operate continuously in a cloud of steam that would stall a direct current motor in five minutes. Many of them are subject constantly to the action of chloride fumes, which are so corrosive that the copper parts of the motors and switches are green from their influence. In many of the operations enormous starting torque is required, the initial torque being in some cases four times the normal torque of the motor. The plant has proven so satisfactory that it has recently been extended by ten or more of the Tesla Type C motors made by the Westinghouse Company.

AN INGENIOUS LIGHTNING ARRESTER PRINCIPLE.

The principle of the well-known Garton-Daniels lightning arrester is well illustrated by the following cross-sectional view of their device. It consists of a tube, in which is a solenoidal plunger resting on a carbon contact. The contacts shown in the lower part of the figure are very near together but not quite touching. The discharge enters the arrester by the binding post A, and from thence crosses the non-inductive resistance B, which is in multiple with the coil F, through conductors which are bedded in the slate base of the arrester. From thence it passes to the flexible cord C and across the spark gap to ground. The discharge, it will be noted, takes its path through the non-inductive resistance in multiple with the coil. If the dynamo current tends to follow, it will pass for the most part through the coiled bobbin F, which is thereby energized, drawing up the iron armature E, and introduces a second air gap into the circuit to such an extent that the arc immediately goes out. The current in the bobbin then ceases, the



SHOWING PRINCIPLE OF ARRESTER.

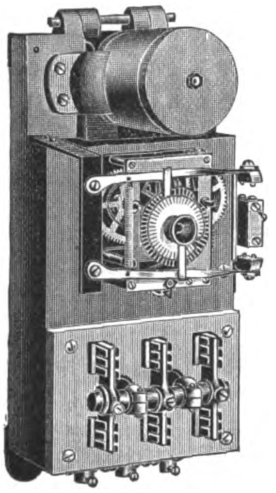


ADAPTATION FOR RAILWAY CIRCUITS.

plunger drops, and the arrester is ready for another discharge. This arrester is exceedingly effective, and there is no reason why it should not be. The arc occurs within a tube which is very nearly air tight. The oxygen is rapidly consumed, which assists in extinguishing the arc. The air gap can be made very much smaller than in the case of the non-arcing arrester, and hence the discharge is more certain to follow the path that was intended for it. As there is but one moving part, the arrester is simplicity itself and not liable to get out of order. In the second figure the arrester is shown as used on railway circuits. It is manufactured by the Garton-Daniels Electric Company, Keokuk, Ia.

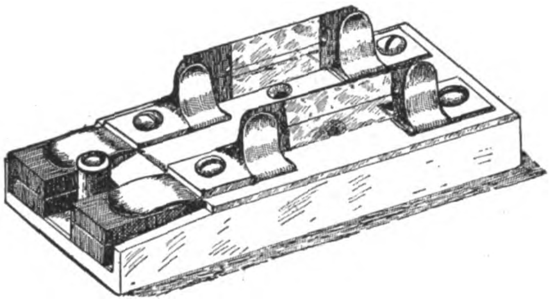
AN AUTOMATIC ELECTRIC TIME SWITCH.

It is only recently that the demand for a good electric time switch has been appreciated by makers of electrical apparatus, and the accompanying illustration depicts a switch of this character, which, it is claimed by the makers, embodies features of marked superiority. The general design is clearly shown in the cut. It consists of a two or three pole, double break, knife-blade switch, which is operated by an electromagnet in conjunction with a lever and spring, which makes the opening and closing of the circuit practically instantaneous. The operating current is controlled by an eight-day clock movement. Two discs are mounted on the hour stem of the clock movement and are held in position by an adjustable thumb nut. These discs are divided into twenty-four sections, each representing an hour of the solar day. Each dial has a zero point notched in the periphery, which allows the lever or contact arm to drop. When the time of switching arrives the contact arm closes a circuit through one of the magnet coils, which in turn closes the knife switch. When the time of cutting out the lights arrives the other dial operates its contact arm, which again energizes the magnet and opens the knife switch. The operating current is only used at the times of switching on and off, and then only for a brief period. There is, therefore, no continuous consumption of current in the magnets and no danger of overheating them. These switches are very carefully made and rigidly tested in the factory before being offered to the consumer. They are manufactured by the Cleveland Electric Company, Cleveland, Ohio.


AUTOMATIC TIME SWITCH.

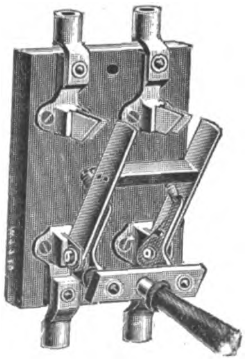
A COMBINED TELEPHONING FUSE AND LIGHTNING ARRESTER.

In the accompanying cut is depicted a combined lightning arrester and fuse for telephone lines. The foundation of this apparatus is a porcelain base, upon which are mounted two carbon blocks separated by perforated mica. One of the blocks rests on the ground plate and the other is directly connected on to the line, the idea being to produce an arrester on the gap principle. The perforations of the mica are, of course, liable to become partly filled with carbon dust after continuous use, and to anticipate this difficulty the blocks are made removable, can be pulled out and the carbon dust blown out of the mica separator, and by replacing them the arrester is in working order again. The fuses are the ordinary copper field fuses about 2 ins. long, and rest between clips, as shown in the cut. The combination is said to be very effective and satisfactory. It is made by the Electric Appliance Company, Chicago, Ill.


COMBINED FUSE AND LIGHTNING ARRESTER.

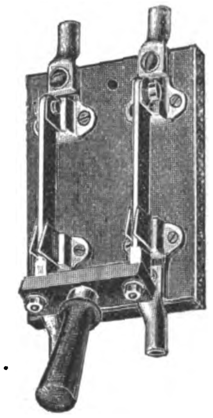
IMPROVEMENTS IN SWITCH CONSTRUCTION.

The accompanying illustrations depict several types of jack-knife switches, which are finding favor among constructing electricians. The first is a quick break switch. In this switch the handle strains on a spring and the switch jaws will not pull out until the spring is sufficiently strained to throw them out with a snap. The breaking in this respect is not under control of the operator; is exceedingly prompt, and minimizes the arcs.


QUICK BREAK SWITCH.

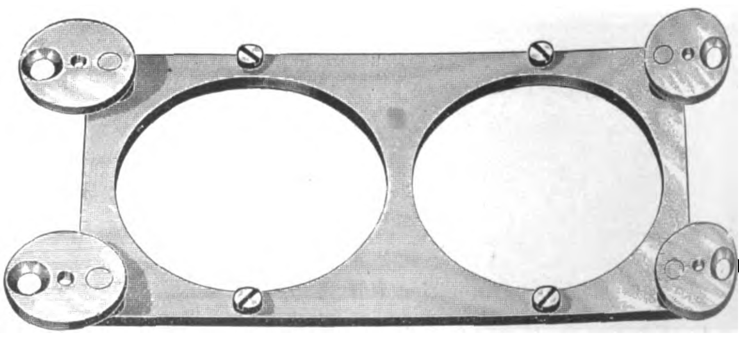
In the second cut is shown a very desirable switch for switchboard work. Its claims for excellence are in its workmanship, the contacts being made with the greatest care, and the joints and machine work being very substantial.

These switches, together with several other new and desirable types, are manufactured by the Warren-Medbery Company of Sandy Hill, New York.


PANEL SWITCH.

IMPROVEMENTS IN ELECTRICAL HARDWARE.

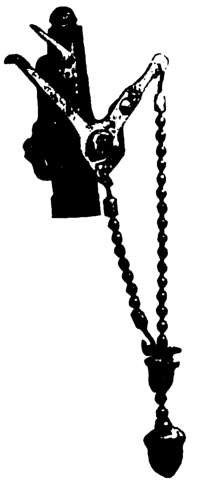
To meet the demand for artistic and ornamental electrical hardware for use in public buildings and the better class of private residences, the Hart & Hegeman Manufacturing Company, 52 High Street, Hartford, Conn., is manufacturing a line of plates for single flush switches, or gangs of flush switches, and claim that for quality of material, workmanship and style of finish they will meet the most exacting demands of architects and others. Any finish in hardware can be duplicated in these plates, which are made of any size, from one-switch capacity up to one hundred or more. To enable them to fill orders promptly this company keeps constantly in stock a line of plates ranging in capacity from two to eight switches. Among the finishes always on hand are nickel, bronze or polished brass. While these sizes and finishes are found to answer all ordinary requirements, the company is prepared to furnish other sizes and special finishes on short notice. We illustrate herewith a Hart gang back plate for two switches.


GANG BACK-PLATE.

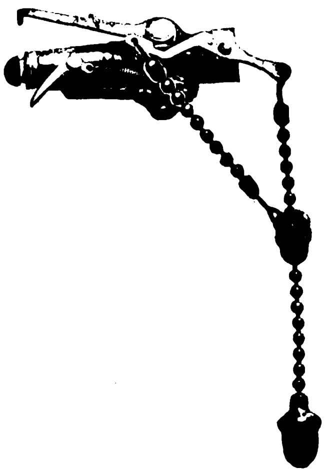
The openings in these back plates are all of the same size, enabling them to accommodate single-pole, double-pole, three-way, four-way or electrolier switches, as may be desired. Hart gang plates and gang switches are carried in stock by almost all dealers in electrical supplies, and therefore can be procured in any part of the country without delay, and any desired combination of plates and switches made.

ELECTRIC GAS BURNER ATTACHMENTS.

The accompanying illustrations show gas burners electrically lighted on the pendant plan. The manufacturers state that they may also be operated by a stiff rod, and that the parts are specially designed to prevent short-circuiting. It will be noted that both contacts are held well out of the flame and cannot lose their tenacity and springiness, or become oxidized by reason of the heat. The valves have easy attachments for removing them for cleaning, and show by the position of the balls on the chain whether the gas is on or off. The springs are of phosphor bronze, and the burner is highly finished from solid brass rod stock. The valves are well proportioned, and ground in the stem and seat to make a perfect fit. These attachments, which are also adapted for horizontal gas jets, such as are used on billiard tables, are manufactured by Rousseau's Electrical Works of New York, which are also placing on the market a new line of window and door springs for electric alarms. These springs are thoroughly insulated with rubber, with the exception of the exposed parts, which are insulated with mica. They can be easily put in place with simple tools, and are said to be very effective. The company states that it has purchased all patents, tools, etc., for the manufacture of the above and other specialties, from David Rousseau, who formerly manufactured them for his own use. The new company will do no contract work, but will manufacture these specialties exclusively for the trade, and is arranging with all supply houses to handle its goods for the greater convenience of its customers.



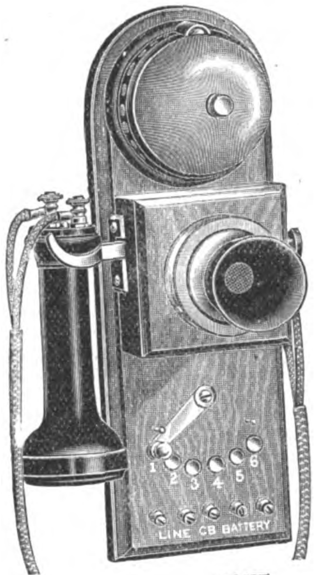
PILLAR BURNER CLOSED.



BILLIARD BURNER OPEN.

A NEW TELEPHONE.

In the accompanying illustration is depicted an intercommunicating telephone, which is exceedingly compact and simple, and has withal a very important improvement over the ordinary instrument of this type. In most intercommunicating systems it is necessary to throw the switch lever to the home station when the party is through talking, for otherwise it is impossible for the instrument to respond to an incoming call from the other station. To improve this some makers have used automatically restoring switches, actuated by the hanging up of the receiver. In the device illustrated the scheme of connection is such that the position of the switch lever matters not, as far as incoming calls are concerned, thereby obviating special devices. This system is adapted for key or plug boards, and also for common return and metallic circuits. The calling battery consists of but three cells, placed in a central location. The instrument is fitted with a granular transmitter and an improved English standard receiver, and the workmanship is first-class. It is manufactured by the Connecticut Telephone and Electric Co., Meriden, Conn.



A NEW TELEPHONE.

PERSONALS.

MR. KEMPSTER B. MILLER has severed his connection with the Western Telephone Construction Company and has moved to Scranton to assume charge of the courses in Telephony and Telegraphy of the International Correspondence Schools at that place. As Mr. Miller is an authority on these subjects, the International Correspondence Schools are fortunate in securing his services.

MR. F. E. DRAKE of the Walker Company has been selected as electrical adviser to Commissioner General Ferdinand Peck of the United States to the Paris Exposition of 1900. Mr. Drake will sail for France with the Commissioner General and party on the steamer La Touraine from New York on Sept. 3. He expects to return to this country about the middle of October and will then resume his duties with the Walker Company.

MR. E. J. WESSELS, former managing director of the Standard Air Brake Company, now owner of the illustrated weekly newspaper, "The Universe," has just purchased all right, title and interest in "Sunbeams Magazine." This publication has been in existence for seven years. It enjoys an excellent advertising patronage, and has a large subscription list. Mr. Wessels will merge "Sunbeams" in "The Universe." The publication office will be at 150 Fifth Avenue, New York City. "The Universe" has rapidly worked its way into favor, and now goes to all parts of the world.

TRADE PUBLICATIONS.

THE CONSOLIDATED SAFETY VALVE COMPANY, New York, has issued a neat catalogue of its goods. It is handsomely illustrated and describes their goods most completely, and numerous pictures of their works at Bridgeport give an idea of their facilities and their ability to fill large orders on short notice. Copies will be sent to applicants mentioning this paper.

THE JOSEPH DIXON CRUCIBLE COMPANY, of Jersey City, N. J., has issued a catalogue on the subject of graphite as a lubricant. The book is replete with technical tests and professional opinions on the subject, and, as is to be expected, advertises the admirable graphite and graphite compounds of the company. It forms very interesting engineering reading matter.

THE HAYDEN & DERBY MANUFACTURING COMPANY, New York, is now mailing an extensive catalogue on its injectors and ejectors. It is thoroughly illustrated, and the apparatus is completely described, and the essential dimensions are given. The catalogue is valuable as a reference to anyone who is using the goods of this company and the prospective buyers of such apparatus. Applicants for the catalogue, mentioning this paper, will receive a copy.

THE CROWELL APPARATUS COMPANY, of Indianapolis, Ind., is circulating an interesting little pamphlet describing their goods, which consist of experimental devices for school and for students' use. It illustrates many experiments, which can be performed with simple materials. To the instructor in physics and to the student, this book is well worth writing for, for many of the experiments are decidedly unique, and show to excellent advantage the principles of physics illustrated therein.

THE CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., has issued a catalogue which describes in detail the construction of their jack-knife switches, panel and fuse boards, and switch parts. This little catalogue is valuable to all who have to do with switchboard contracts of any kind, as experience has shown that in making up a switchboard there are many parts that can be purchased much cheaper than they can be made, due to the fact that manufacturers like the above-named firm make a specialty of such parts, which are turned out in large quantities by special machinery.

THE RELIABLE ELECTRIC MANUFACTURING COMPANY, Worcester, Mass., has recently sent out to the trade a new catalogue replete with handsome illustrations showing their telephone apparatus as well as their various electrical supplies and specialties. The company claims that only the best workmanship and material are employed in their telephone apparatus, of which they make a specialty and which, it is stated, is of the latest design, and is built upon correct electrical and mechanical principles. The offices of the company are at 86 Foster Street, to which applications for this catalogue should be addressed.

THE MICA INSULATOR COMPANY of Chicago and New York have issued a neat and very desirable catalogue. It comprises a short history of mica down from the time of Thales and Mahomet to that of the Anglo-

Indian. It is illustrated, and gives an excellent idea of the mica mines of India. The chief value of the catalogue to the electrical engineer, however, obtains in the tables and information concerning mica and micanite. The tables comprise resistances, break down voltages of a large number of insulators, while very instructive data is comprised under the titles of "Armature Notes and Commutator Construction."

THE CONNECTICUT TELEPHONE AND ELECTRIC COMPANY, Meriden, Conn. have issued a little yellow covered catalogue, which describes in complete detail the numerous forms of telephones that they manufacture. The little book is profusely illustrated, and shows the construction as well as the general appearance of their apparatus. The goods comprise long-distance 'phones, special anti-induction 'phones, desk 'phones, intercommunicating battery call 'phones, both of the block and switch type; transmitters and receivers and magnetos of all sizes. They also have a line of telephone parts, batteries, lightning arresters and central station switchboards.

THE NEW CATALOGUE of the Western Electrical Supply Company, St. Louis, is a very extensive volume, descriptive of the many goods of which they have the agency. It consists of 753 pages handsomely illustrated matter. The apparatus and appliances are exhaustively described, and the purchaser will have no difficulty in selecting what he needs from the illustrations and descriptions. In addition to the description of the goods the catalogue is made of greater engineering value by the addition of numerous tables, relative to the properties of wire, weights, lengths and resistances. The descriptions are ably written and technically accurate. The book is handsomely bound in cloth and is a decided addition to the reference volumes of the contractor or electrical engineer.

THE G. F. HARVEY COMPANY, of Saratoga Springs, N. Y., has issued a little pamphlet on "Vitogen." Vitogen is a substance which is adapted for treating wounds or burns which are difficult to heal, and particularly electric burns. It is an antiseptic dusting powder, is non-irritating, nonodorous and unaffected by light and heat. Those who have to do with or handle large currents appreciate the difficulty with which electric burns heal, particularly those which are due to arcs between brass or copper terminals. They will therefore be interested in this material, and will do well to send for this booklet. The company have received a great many letters from electricians, speaking of the merits of their compound. It is said to instantly allay all pain due to electric burns, even if they be very severe.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has issued a booklet, entitled "One-fourth of a Million Horse-power of Polyphase Transmission Apparatus." The book is very artistically gotten up, and concisely describes a few of the many plants of polyphase apparatus which the Westinghouse Company has installed or supplied the machinery. It certainly impresses the reader with the fact that the Westinghouse Company is doing an immense amount of business, and is supplying power transmission machinery to fill widely different electric and mechanical requirements. Another publication by the same manufacturers is entitled, "Electricity for Machine Driving." It is profusely illustrated with excellent half-tones, showing the many applications of the Westinghouse Tesla motor to the operation of machine tools.

THE NEW CATALOGUE of the American Stoker Company, New York, is an interesting dissertation on their apparatus, written from an engineering standpoint. It is handsomely illustrated, with half tones and diagrams. The apparatus of the company is described and illustrated in detail. Following this are shown the methods of applying the stoker to different types of boilers, and beyond are reports of extensive tests. The whole is supplemented by an excellent collection of photographs of numerous plants, in which the company has installed its apparatus. An interesting series of photographs consists of ten different views of the power house of the Shoenberger Steel Company at Pittsburgh. The photographs were taken at intervals of twelve minutes during the busiest part of the day. Nine stacks in all are shown. The six stacks which receive the flue gases of furnaces equipped with American stokers show no smoke whatever, while the three other stacks, which are not thus equipped, are profusely smoking in all of the pictures. Copies of the catalogue will be sent on application.

BUSINESS NEWS.

THE DEARBORN DRUG AND CHEMICAL WORKS, of Chicago, have recently analyzed fourteen boiler feed waters and shipped two carloads of suitable scale solvents to large sugar concerns in the Hawaiian Islands.

THE WESTERN ELECTRIC COMPANY, Chicago and New York, is placing upon the market its new long-burning arc lamp using the name "Midget" in describing it, owing to its size, the lamp being but twenty inches in length. The name "Midget," however, is no longer used by them in describing this lamp, but the name "W. E. Petite" has been adopted.

THE WESTINGHOUSE MACHINE COMPANY has already begun to reap some benefit from the recent brilliant successes of American arms in Cuba. They are advised that their New York office has received the initial order for a complete steam plant, involving a 100-h.p. Westinghouse engine and Westinghouse generator, together with boiler, pump, piping, etc., this plant to be installed in Santiago de Cuba.

THE W. H. ELLIOTT ELECTRIC COMPANY, of Cleveland, has just completed the repair of five 100-k.w. generators, belonging to the Mahoning Valley Railway Company, Youngstown, Ohio, which were badly damaged by lightning. The first generator was received in Cleveland on Wednesday morning, and on the following Monday morning it had been repaired, returned to Youngstown and was again in commission.

THE LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, was burned out on July 15th. The fire originated in the building two floors below, and spread through the elevator shaft into their floor. They have now moved into larger quarters in the World Building, on Ontario Street. They are now in running order, and can handle any orders that may be sent to them. They manufacture slow-speed dynamos and motors, and have special facilities for testing and repair work.

AMONG RECENT SHIPMENTS of Frontier Tandem gasoline engines by the Frontier Iron Works, Detroit, are: One 60 h.p. to Norway, Mich., for a village electric lighting plant of 600 lights; one 40 h.p. to Bay City, Mich.; one 40 h.p. to Ogdensburg, N. Y.; one 40 h.p. to Wichita Falls, and several 25 and 20 h.p. engines of the same type. The company claims for this engine a regulation equal to that of a steam engine, adapting it to electric lighting and similar duty at a decided economy of fuel and attendance.

THE BEACON LAMP COMPANY of New Brunswick, N. J., have been making some very satisfactory tests on their lamps, with a view to bringing out the fact that they will retain their initial candle-power for a large number of hours. The lamp is claimed to retain its initial candle-power for over 300 hours, and the company also claim that, after 300 hours' burning the lamps give more light and use less current than when started, and show no blackening. They make lamps of from 2.75 watts per candle upward, the standard efficiency being 3.5 watts.

DISSOLUTION OF PARTNERSHIP.—The co-partnership heretofore existing between Edgar H. Freeman, Walter H. Tobey and another, engaged in the business of electrical contracting and the sale of electrical supplies at No. 32 North Water Street, Rochester, N. Y., under the firm name and style of "Standard Electric Construction Company," was dissolved by mutual consent on June 23, 1898. The business will be continued under the same firm name and style by Edgar H. Freeman and Burton A. Vandy, who assume all the obligations of the old concern.

THE FAMOUS FILTER COMPANY, St. Louis, Mo., has made the following recent sales of its "Famous" oil filter: The Syracuse Construction Company, Syracuse, N. Y., third order; the Indianapolis Gas Company, Indianapolis, Ind.; the Electric Lighting Company, Mobile, Ala.; the New York Athletic Club, New York; the St. Louis Ice and Cold Storage Company, the Huse & Loomis Ice Company, second order, the Chonteau Avenue Brewery, the Lafayette Brewing Company, the Wellman-Dwyer Tobacco Company, and the St. Louis Cooperage Company. St. Louis, Mo.

THE NEW BRITAIN MACHINE COMPANY, New Britain, Conn., has compiled a new catalogue on its Case engines and has supplemented it with a very complete series of illustrations of its direct connected sets. The Case engine is adapted to connect directly to any dynamo of the proper speed and capacity. It is well known among steam engineers as a standard high speed engine of small capacity. It is thoroughly inclosed and adapted to the severest service. The catalogue gives dimensional drawings of the engines, which will be useful to those contemplating special applications.

"SOME AMERICAN NOVELTIES INTRODUCED INTO AUSTRALIA" is the title of an article printed in the Williamstown Advertiser, a local daily paper of Williamstown, a portion of Melbourne, Australia, which describes devices constructed for the purpose of closing electrical circuits and thereby ringing bells, telephones or fire alarms. Among these novelties was the fire cable of the Montauk Multiphase Cable Company of New York, which was submitted to a highly satisfactory and practical test. It is stated that this cable has been recommended by the Metropolitan Fire Brigade of Williamstown, and will be introduced into the large mercantile houses of that city. The cable can be attached to an electric bell, to a telephone and to a fire alarm. The peculiar property possessed by this cable is that when it is ignited or affected by dangerous heat it will instantly close any circuit to which it may be connected.

THE AMERICAN SCHOOL OF CORRESPONDENCE, Boston, states that the original plan of its electrical course has been enlarged and improved to keep closely in touch with the latest advances in electrical science. The simplicity and accuracy of the thorough course now offered under the supervision of well-known electrical experts will amply repay careful study on the part of the ambitious workman anxious to better his position. The school has been chartered by the Commonwealth of Massachusetts as "an institution of learning in all branches," thus placing it on a level with other high-grade educational institutions. It aims to distribute technical knowledge to a large army of men who could never enjoy the benefits of a college education were it not for the modern correspondence school, and the terms are so arranged that the poorest-paid workman can secure this valuable instruction, thereby increasing his wage earning ability. A handbook, giving complete information, will be mailed to all interested.

THE WALKER COMPANY, of Cleveland, Ohio, which some time ago was awarded a contract for twenty 500 h.p. alternating current generators with other apparatus for the Union Carbide Company, of Chicago, has, through its vice-president, Mr. S. H. Short, secured a duplicate of this contract for the same company. The order as it stands comprises over 20,000 h.p., in generators. The shops of the Walker Company are running night and day on existing orders, and the recent large additions to the plant will be taxed to their utmost to put out the immense amount of work already in hand.

THE FUEL ECONOMIZER COMPANY of Matteawan, N. Y., reports recent sales as follows: Milwaukee Electric Railroad, Milwaukee, Wis., 2000 h.p.; Worcester Bleach & Dye Works, Worcester, Mass., 350 h.p.; Merchants' Cotton Company, St. Henri, P. Q., 600 h.p.; Excelsior Mills, 300 h.p.; Lehigh Valley Coal Company, Wilkesbarre, Pa., 2000 h.p. (two orders); Western Cold Storage Company, Chicago, Ill., 300 h.p.; Cheney Brothers, South Manchester, Conn., 2000 h.p.; Blackstone Mills, Blackstone, Mass., 500 h.p.; La Belle Mill, Water & Power Company, Coldfield, Colo., 1000 h.p.; Dominion Cotton Mills Company, Magog, P. Q., 1000 h.p. (twelfth order); Frick Company, Waynesboro, Pa., 150 h.p.; D. M. Bare & Co., Roaring Springs, Pa., 600 h.p.; Rome Brass & Copper Company, Rome, N. Y., 350 h.p.

DUPLICATE ORDERS.—The Cling-Surface Manufacturing Company, of Buffalo, N. Y., states that the DeLemar Nevada Gold Mining Company, DeLamar, Nev., was so well pleased with the results derived from three barrels of Cling-Surface belt dressing received early in August that on August 20th it placed a duplicate order for three barrels more. Six barrels in one month to one concern is considered by the company as a very good order, and effective testimony to the efficiency of its dressing. The Cling-Surface Company reports that it is behind in its orders, of which it has a large number on hand from all parts of the country, from Maine to Mexico, and from Florida to Washington; also that its business during the past month was the largest in the history of the company.

THE WARREN-MEDBERY COMPANY, manufacturers of inductor alternators, Sandy Hill, N. Y., reports that its works are now running to their utmost capacity, day and night, in order to fill the orders for their apparatus, and that their business has increased over 100 per cent within the last sixty days, the demand for inductor machines reaching far beyond their expectations. They have recently made a large addition to their works, and the new machinery is now being installed, when they hope soon to be able to meet all demands upon them for alternators. They are also manufacturing a fine line of standard white marble switchboards, and a full line of the celebrated "Medbery" and "Standard" switches, so well and favorably known. The "Medbery" insulation and overhead equipment for electric railways is now being manufactured by this company, who are prepared to furnish this high grade material promptly.

MR. JAMES G. BIDDLE, 910 Drexel Building, Philadelphia, reports a very good demand for the new "Jagabi" portable testing set which he is selling for Willyoung & Company. The Philadelphia & Reading Railway Company has ordered several sets for testing the signal systems on its various divisions, and among other recent customers may be mentioned the United States Naval Academy, Central Union Telephone Company, Jenney Electric Motor Company, Ahearn & Soper, J. H. Bunnell & Company, Western Electric Company, Engineer's Office, District of Columbia, etc. The "Jagabi" portable testing set is probably the most compact instrument of its class on the market. It comprises a Wheatstone bridge, rhoestat, D'Arsonval galvanometer, silver chloride battery, and keys for galvanometer and battery, all mounted in a handsomely finished mahogany case. The theoretical range of measurement is from one one-thousandth ohm to over eleven megohms. Descriptive pamphlet No. 295 will be mailed to anyone interested in the subject.

ON JULY 1ST the name of the Burnham-Hall-Chase Company of Boston was changed to the Burnham Electric Company. Mr. Hall has disposed of his interest in the concern to Mr. Emery H. Rogers, a well-known and influential business man of Boston, Mr. Rogers assuming the presidency of the concern. Mr. W. W. Burnham continues as treasurer and manager and Mr. M. B. Chase has charge of the technical end of the business. The company states that its business has grown very rapidly since it was started last January, and that it is sending its storage and primary battery outfits all over the United States and to foreign countries, and that many of the large dental and surgical supply houses are handling these goods. The company states further that it has some flattering testimonials from customers, old and new, some of them having used the "Excello" improved gravity battery for eight years and more, and that favorable reports are being received from telephone companies and fire alarm and railroad signal superintendents, who have tested this battery.

TOURS IN THE ROCKY MOUNTAINS.

The "Scenic Line of the World," the Denver & Rio Grande Railroad, offers to tourists in Colorado, Utah and New Mexico the choicest resorts, and to the trans-continental traveler the grandest scenery. Two separate and distinct routes through the Rocky Mountains, all through tickets available via either. The direct line to Cripple Creek, the greatest gold camp on earth. Double daily train service with through Pullman sleepers and tourists' cars between Denver and San Francisco.

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Write S. K. Hooper, G. P. & T. A., Denver, Colorado, for illustrated descriptive pamphlets.

THE CENTRAL ELECTRIC COMPANY, of Chicago, reports a brisk trade on lightning arresters, and is issuing some very attractive circulars on the Wurts arrester, also the Garton arrester. It is also sending out a circular on various types of electrically heated cooking utensils and appliances, and will be pleased to send the same to anyone on application. Among its other specialties the Central Electric Company reports a large and continuously increasing demand for the Samson battery, which has attained an enviable reputation as a product for use under conditions requiring the most exacting service. There has been quite recently introduced the new Samson Semi-Dry Battery, which has become very popular by reason of its desirable features. This battery has extra heavy zincs and large carbons contained in a porcelain jar and sealed. Its ampere output is very large, and as it is portable it is adapted for use under conditions where the former type of open batteries could not be used. The company is carrying large stocks of all Samson types, and is prepared to make immediate shipment on all orders.

WHILE IRON AND STEEL ARMORED CONDUIT is being used, to the exclusion of almost everything else, in new conduit work, there is, nevertheless, a great deal of work where iron-armored conduit cannot be used. The most satisfactory substitute under such circumstances is Canvasite Flexible Conduit. This is particularly useful in wiring or rewiring old buildings. The Electric Appliance Company of Chicago is carrying Canvasite Flexible Conduit in all sizes, from ¼ in. to 1¼ ins. The F. & L. push flush switch is another of the most successful of this company's specialties. It is said to be the smallest push switch on the market, the size of the face plate being only 1¾ by 2¼ ins. It also requires a very small opening in the wall, operates with a very slight pressure on

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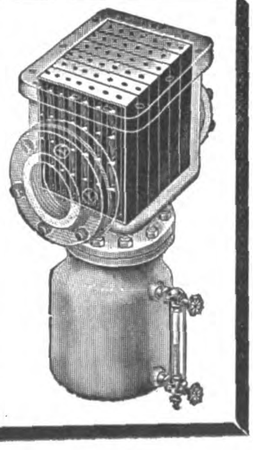

the keys, and has many other valuable features, not the least of which is the fact that it is sold at a price considerably below the market for a push flush switch. The Electric Appliance Company is also distributing circulars regarding the latest model, known as "Model '98," of the Packard transformers, for which they are general Western agents.

THE GENERAL ELECTRIC COMPANY began work on its new machine shop at Schenectady, N. Y., recently, when ground was broken for what will be a most important addition to the great manufacturing facilities of that company. The contracts were let last week to A. & R. Roberts, of the Pencoyd Iron Works, Philadelphia, for the steel construction, and to J. J. Turner, of Amsterdam, N. Y., for the masonry, etc. The cost of the new building is estimated at $175,000. The new machine shop will face on Central Avenue, opposite Building No. 15. It will be 653 ft. long and 166 ft. wide, and will be divided into three aisles, the central one having a width of 65 feet, the side aisles being each about 50 feet wide. The total floor space of this building will be not less than 144,250 sq. ft. It will contain the machinery necessary to handle the very large apparatus which the requirements of modern practice have rendered necessary. The need of such an addition to the manufacturing facilities of the General Electric Company is realized after a visit to the factory at Schenectady at the present time. The many orders, both for large machinery and for large quantities of apparatus, are severely taxing their facilities. The working of night shifts has been carried on since the beginning of the year, and, according to the superintendent, there are few signs of the practice being abandoned for the present. It is expected that the new machine shop will be completed before the end of this year. The machinery will be driven by the current transmitted from Mechanicville, seventeen miles distant. In addition to the new machine shop the General Electric Company is making several important extensions to other buildings. The new foundry, which was recently begun, is now in position to receive the iron work, the support for the great traveling crane having been erected last week. This building, when finished, will contain the largest foundry under one roof in the world.

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"The Continental Limited," a new fast train on the Wabash, now leaves Chicago daily at 12:02 noon for Detroit, Niagara Falls, Buffalo, New York and Boston. This train arrives Buffalo next morning at 5 o'clock, New York at 3:30 and Boston at 5:50 P. M. the next day—only one night on the road. The service, including a dining car, is first-class in all respects. Do not fail to ask for a ticket via the "Continental Limited" on your next trip East.

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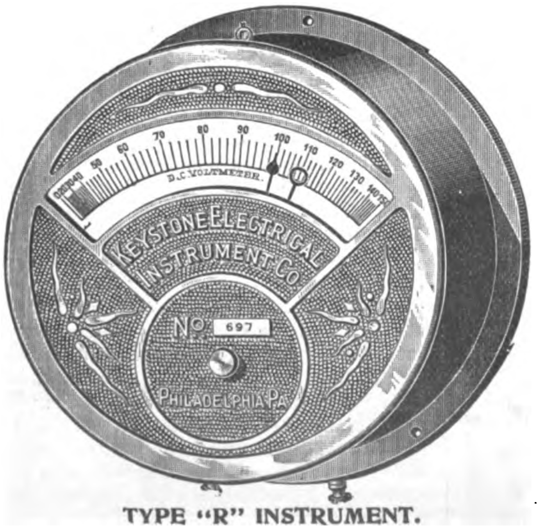
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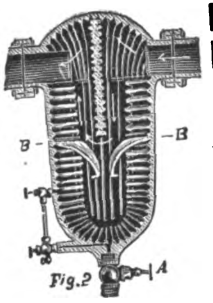

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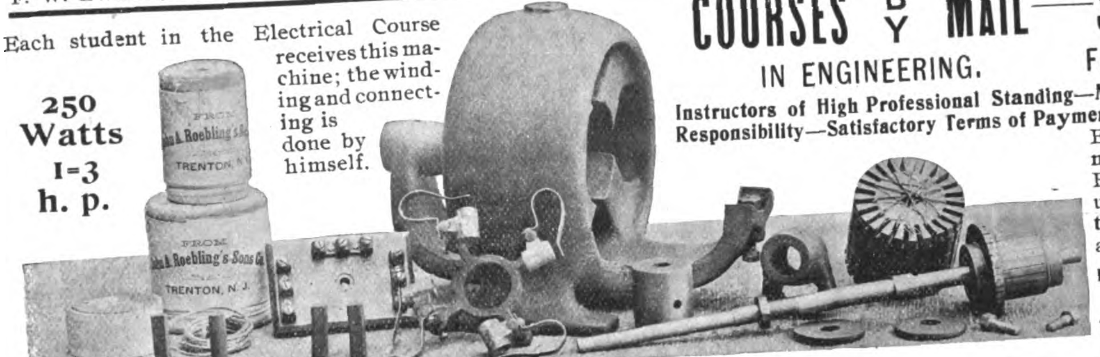

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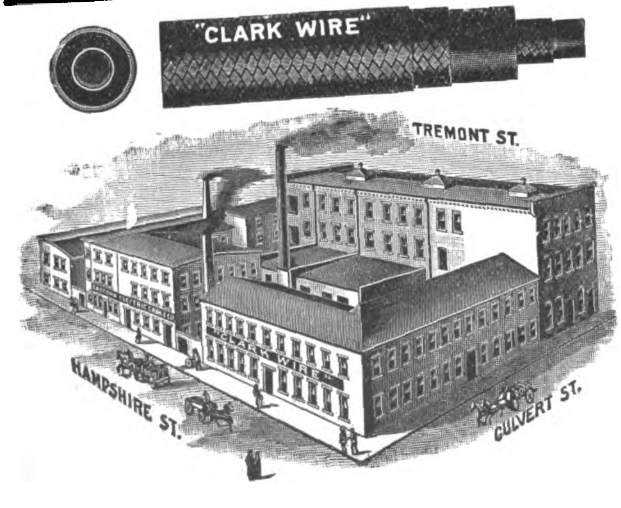
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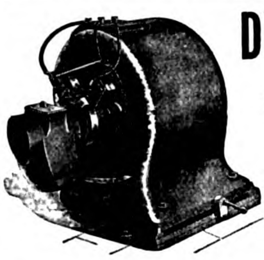

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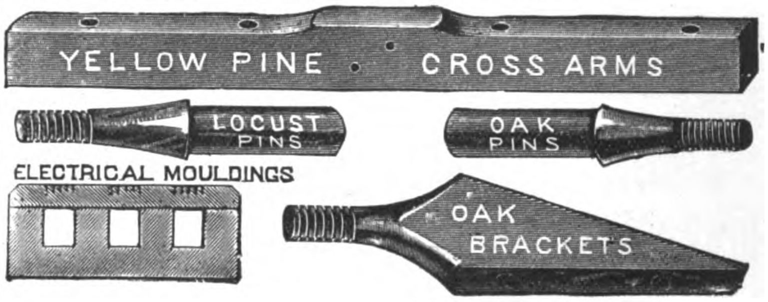

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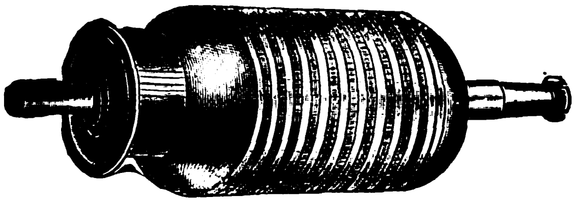

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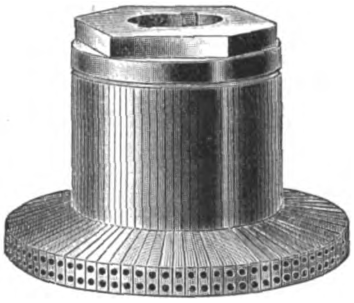

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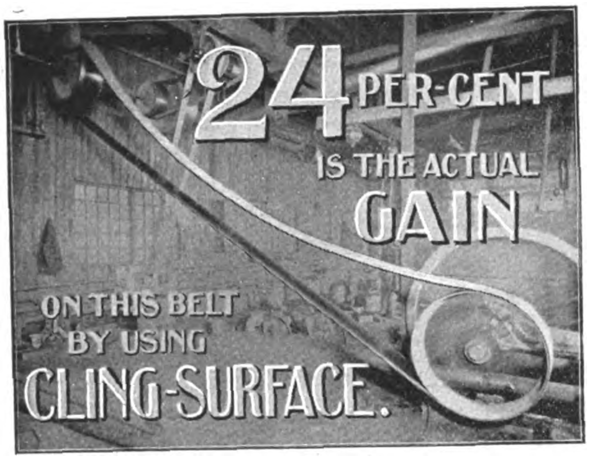

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American Electrician.

Vol. X. New York, October, 1898. No. 10.

THE TRANSMISSION PLANT OF THE FRIES MANUFACTURING & POWER COMPANY.

In the State of North Carolina there are a great many undeveloped water powers varying from 1000 to 10,000 h.p. in capacity, and among these has been selected for development one which is known as the "Shoals," and which is located on the Yadkin River, at a point about 14 miles by road from the twin cities, Winston and Salem.

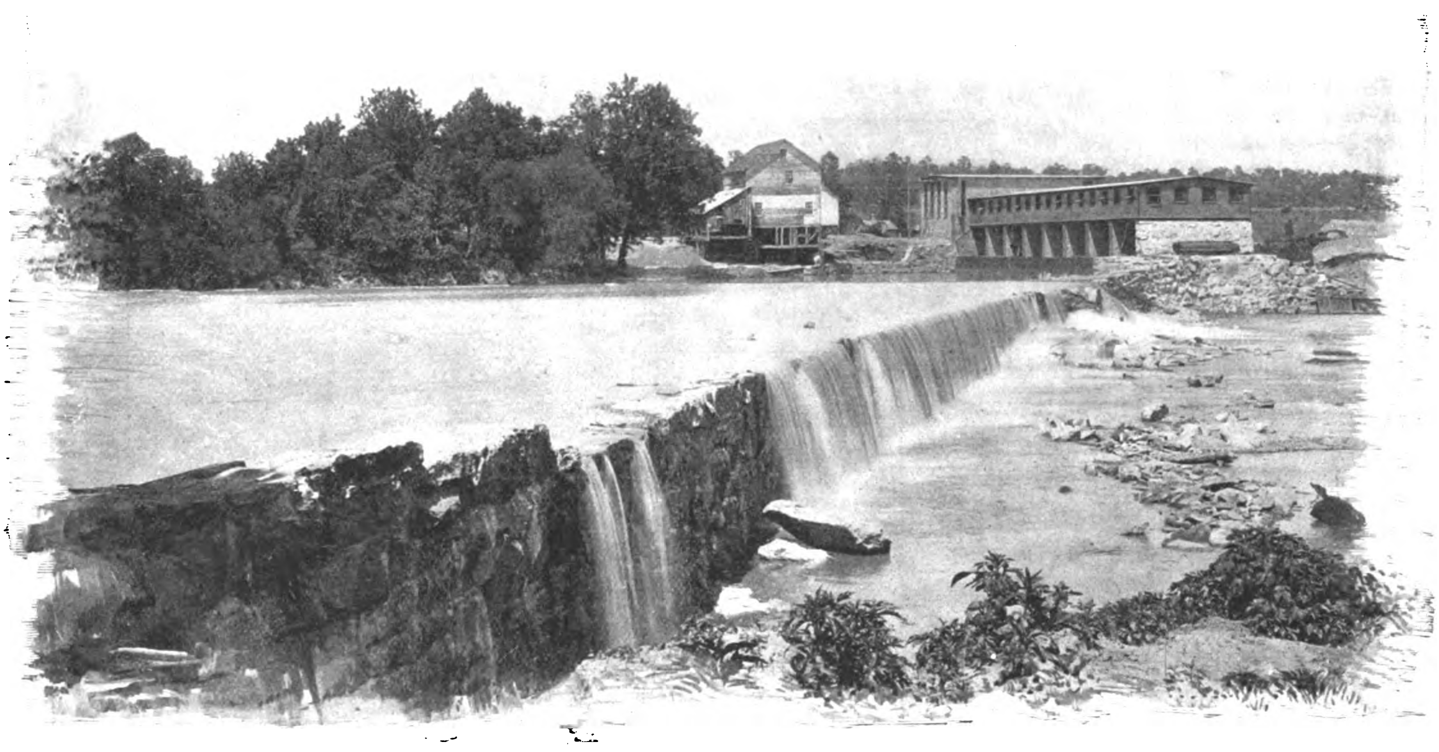


FIG. 1.—GENERAL VIEW OF POWER HOUSE AND DAM.

The fall at this point is about 8 ft., and took the form of rapids before its development. In previous years a portion of this power has been used to operate a saw and grain mill.

The development of this power was by no means a simple problem, for the river, rising as it does in the foothills of the Blue Ridge range, is subject to severe freshets in the rainy season. The country above the power house site is low lying and the employment of a high dam would create considerable land damage. Even so slight an increase of head as 2 or 3 ft. was not practical, and hence the dam could effect but little storage of hydraulic power, and the somewhat irregular flow of the river had to be in a measure depended upon. This is estimated to give with a 10-ft. head from 2000 to 2700-h.p., with a yearly average of about 2300-h.p.

To develop and transmit this power to Winston-Salem the Fries Manufacturing & Power Company was organized.

The plan decided upon by the company's engineer was to build a 10-ft. dam across the river at the "Shoals" and install in a suitable power house a sufficient number of turbines to generate 1000 h.p., the remainder of the available power to be taken care of by future addition.

It was decided to directly connect electric generators to the turbines and to transmit the energy in the form of three-phase currents at a pressure of 10,000 volts to a sub-station in Salem. From this station within a mile radius power is to be distributed at 1200 volts, and for greater distances the power-house pressure will be used. Of course, it is to be understood that at the places where the power is actually used, it is reduced to the proper voltage by suitable step-down transformers.

For the motor service induction types are used when the units do not exceed 50 h.p., and in larger sizes recourse is had to synchronous motors. The electric system adopted was the well-known S. K. C. system, the apparatus for which is built by the Stanley Electric Manufacturing Company of Pittsfield, Mass., and it is to be used throughout.

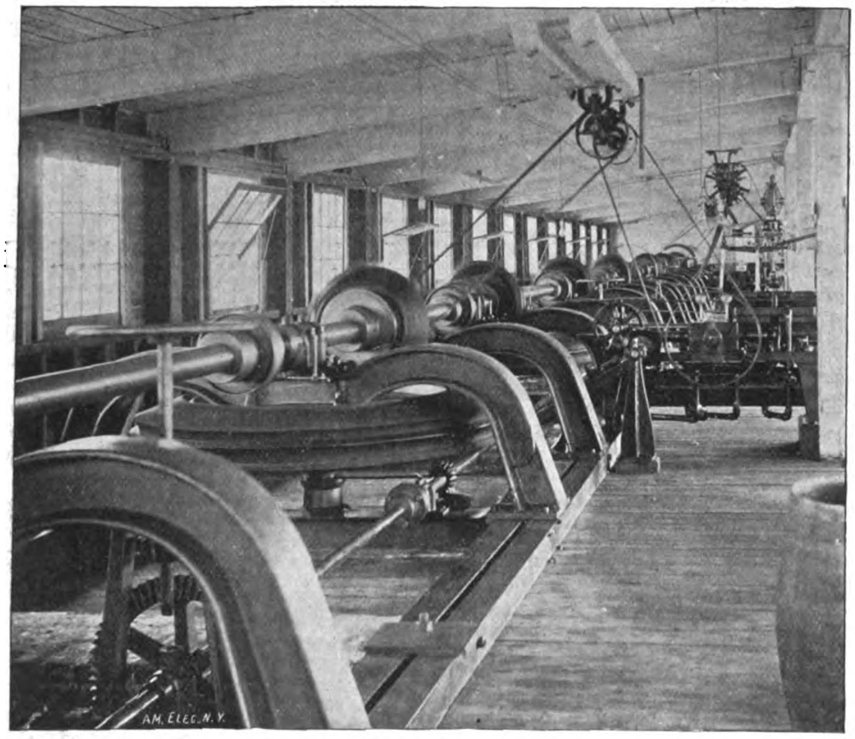


FIG. 2.—VIEW OF MAIN SHAFT AND GOVERNORS.

The hydraulic work was begun in May, 1897, and great precautions were taken to avoid damage from floods and freshets. The dam, of which the frontispiece is an excellent illustration, is built of rough stone, and is 500 ft. long and 10 ft. from the sill to the top of the spillway. At the ends the height is raised by steps to a maximum of 13 ft. The width of the dam is 6 ft. on the top, increasing to double that amount at its base. For a space of 6 ft. in the length of the dam the head is reduced to 9½ ft., where the fish ladder is placed.

The power house is built of brick and surmounts the wheel pits, which are of rough stone. It consists of a generator room and a wheel room, at right angles to each other. The wheel room extends for its entire length into the river, its foundation meeting the dam. It is 145 ft. x 36 ft., and is divided into eight wheel pits or open penstocks, the lower side of each being arched and opening into the tail race. The division walls of the wheel pits are of brick, and also serve as a foundation for the frames carrying the shaft and bevel gears. Each wheel pit is to be equipped with two turbines, with a 2 ft. x 12 ft. waste gate between them.

The present installation consists of one turbine in each pit. They are of the McCormick vertical gear type, manufactured by the S. Morgan Smith Company, of York, Pa., and deliver 165 h.p. each when running under a head of 9 ft. The wheels are submerged and are mounted on a 6-in. pine flooring, supported on I-beams 8 ft. below head water. The draft tubes pass through the floor and extend to the tail race 2 ft. below. Fig. 6 illustrates one of these turbines as it appeared before installation.

The eight wheels are geared onto a horizontal shaft, mounted in bearings supported by the division walls. The vertical turbine shafts carry a large bevel gear with hard wood teeth, meshing with an iron bevel pinion keyed to the horizontal dynamo shaft. Fig. 2 shows this arrangement to good advantage.

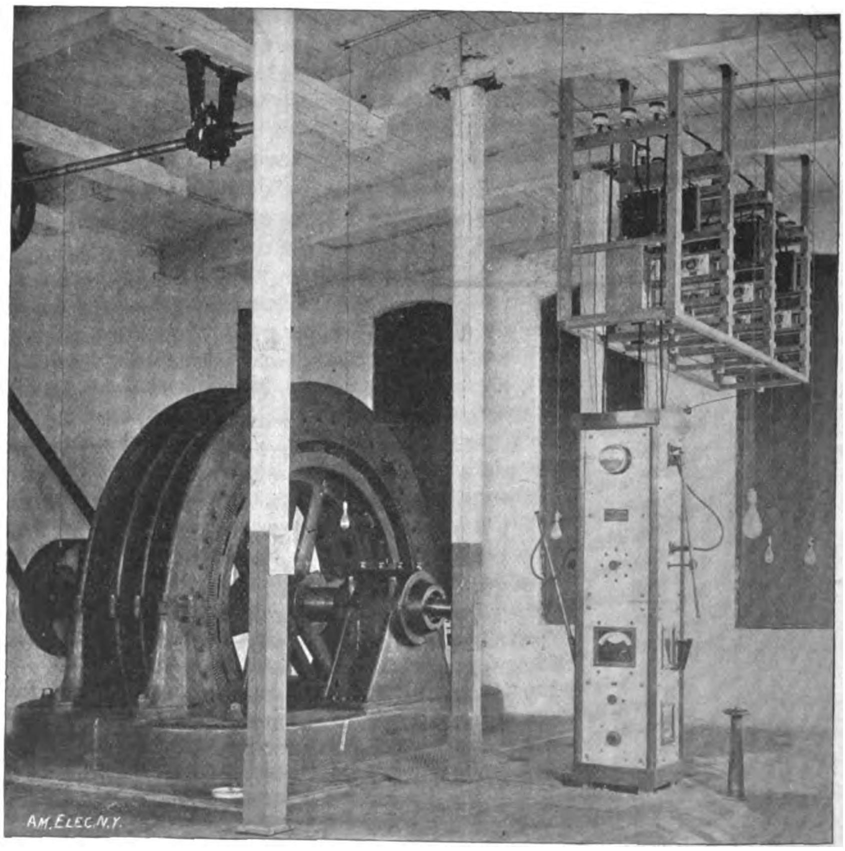


FIG. 3.—GENERATOR AND SWITCHBOARD.

The dynamo shaft is in two sections, each driven by four wheels, and by means of a coupling four or eight wheels may be used. The system is governed by two Lombard type B governors, one for each set of wheels. The governor controls only three in a set, the fourth being controlled by hand.

The generator room is but one story high and 39 by 60 ft. in floor dimensions. It is surmounted by a frame roof 18 ft. from the floor and supported by posts. There is ample room for two generators, with their necessary accessories, but at present there is but one machine with its exciter and switchboard installed. This machine is of the S. K. C. three-phase inductor type and has an output of 750 k.w. at 166 r.p.m. It is particularly interesting, as it is wound for 12,000 volts, and delivers three-phase currents at this pressure to the line without the use of step-up transformers. The efficiency of this machine at full load is claimed to be 93.5 per cent, and its exciting current is but a trifle over one-half of one per cent of its output, being about 86 amperes at 45 volts. The rise in temperature of the hottest part of this machine is but 28 degs. F.

This machine is mounted on a pit foundation, extending 25 to 30 ft. to bed rock, and the pit is thoroughly grouted and plastered within to keep out any high water.

The generator frame is 10 ft. 1 in. in diameter and is divided vertically in such a way that the two halves can be separated on the shaft, allowing room on the inside of the armature for repairs. These are of the simplest character, consisting merely of the renewal of a stationary coil or so, which are readily slipped into place.

The exciter is a 14-k.w. four-pole Crocker-Wheeler machine, driven at a speed of 1100 r.p.m. from the water wheel shaft. It can deliver its current at 70 volts, and is large enough to excite the fields of two such generators. It is interesting to note that the regulation of the water wheels is so close that no separate exciter turbine was needed.

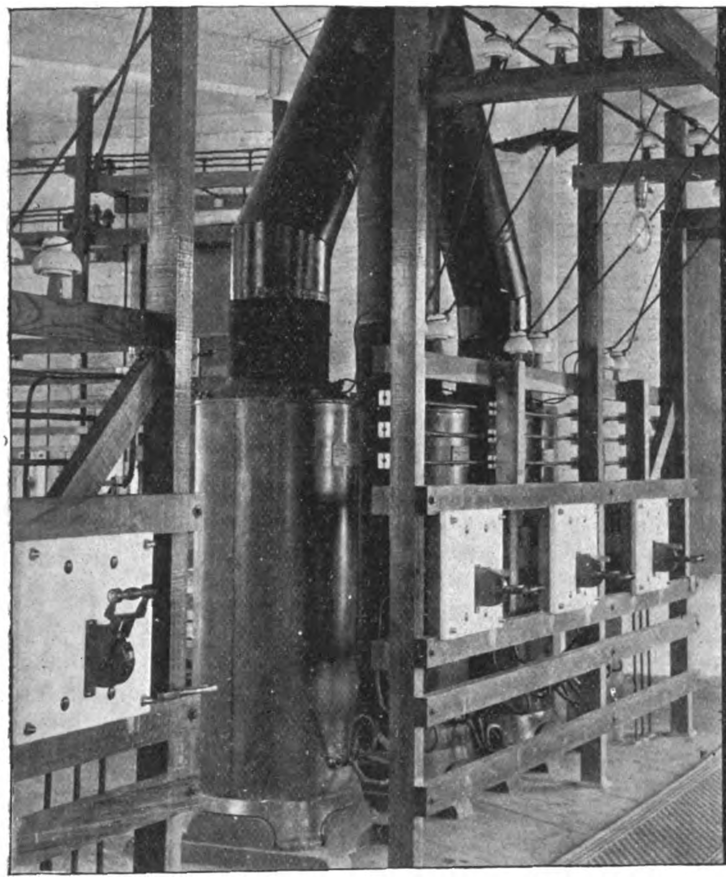


FIG. 4.—SWITCHES AND POWER TRANSFORMERS AT SUB-STATION.

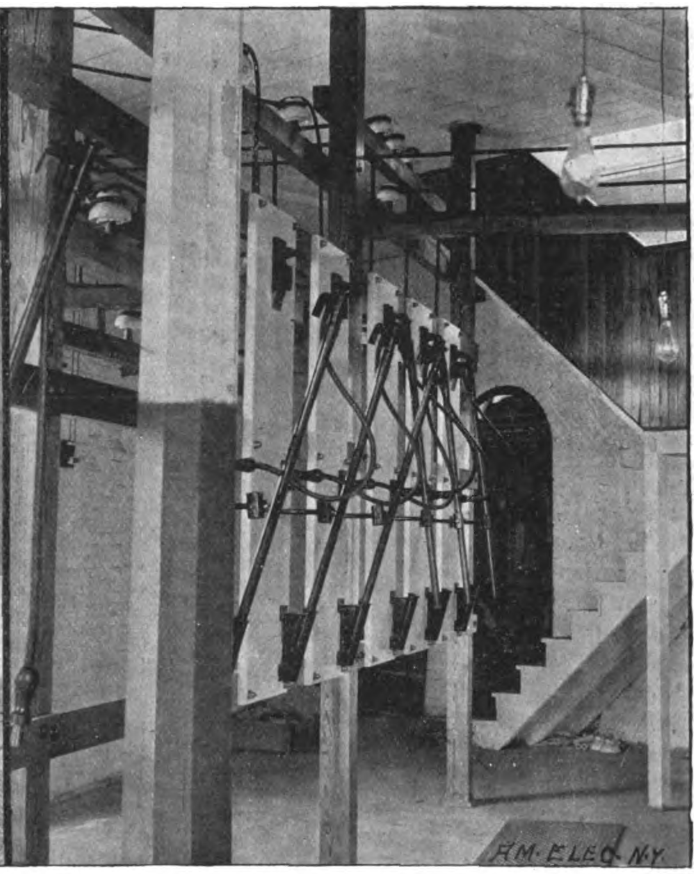


FIG. 5.—COLLECTING BOARD.

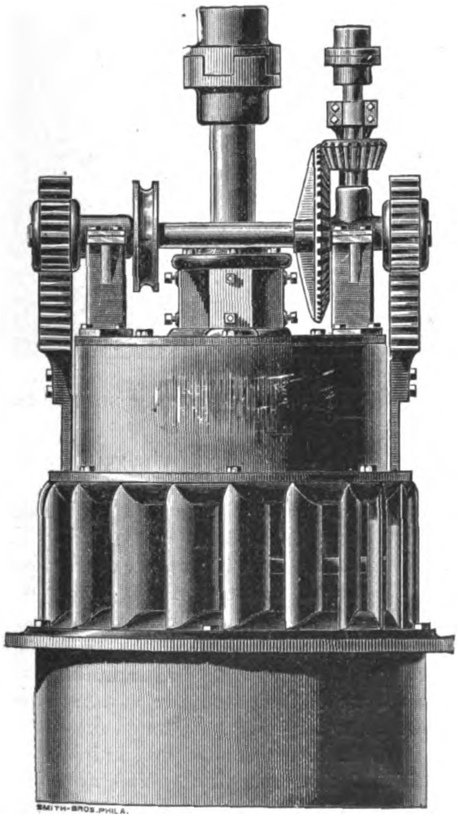


FIG. 6.—TYPE OF TURBINE USED.

The switchboard consists of four white marble slabs formed into a pillar 21 ins. square by 9½ ft. high. The mountings are of lacquered brass and are trimmed in oiled hard wood. This construction is very neat and compact, and as all live contacts are concealed within the pillar it is perfectly safe. Upon the board are mounted three high-tension single-pole single-throw switches. They are of the plug type, with long handles and a bayonet lock. Two 12,000-volt static ground detectors are also used and are connected in such a way that the needles deflect toward the grounded wire.

The generator voltage is read from a static voltmeter connected to the secondaries of a transformer stepping down to 2000 volts. The board is also provided with an alternate current ammeter, a voltmeter and a switch for the exciter circuit, and the exciter shunt rheostat. The field rheostat, the hand wheel of which may be seen to the right of the board, is suspended from the floor 18 ins. below, to provide ventilation and economize space.

Above the switchboard and extending to the wall is seen a lightning protection rack, which comprises three vertical sections, each of which carries a set of arresters and choke coils for each leg of the high-tension

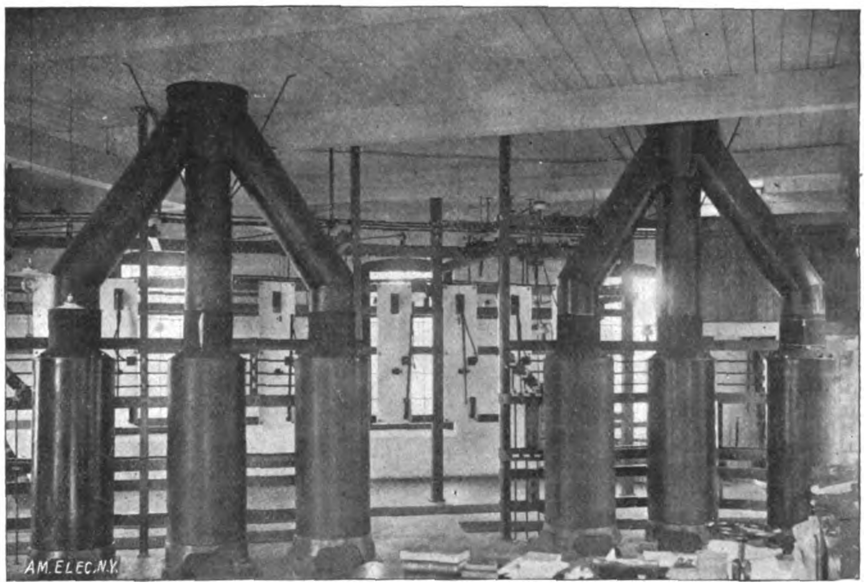


FIG. 7.—POWER TRANSFORMERS.

circuit. These protection sets, like those used at the other points of the line, have choke coils in series with each leg of the circuit, with S. K. C. arresters connected in such a way that there are always four arresters between the line and ground.

The station wiring is placed under the floor. The high-tension wires are insulated for 25,000 volts, and in addition are supported by triple petticoated porcelain insulators on horizontal cross arms. They reach the switchboard by passing through the floor at the base of the pillar. The three power wires pass out of the tops of the pillar and connect to the line.

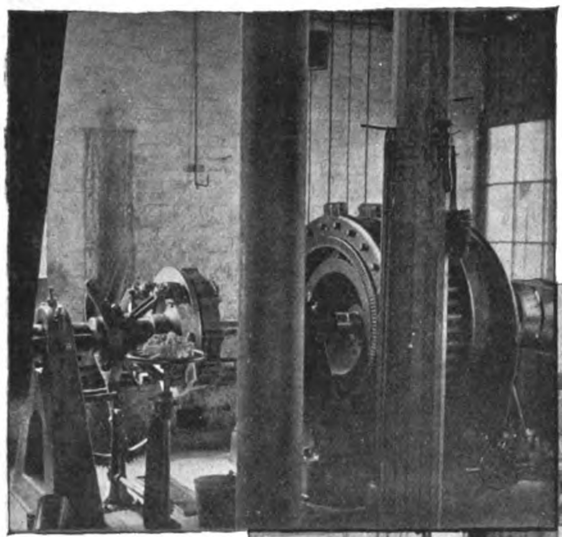


FIG. 8.—300-H. P. SYNCHRONOUS MOTOR IN ARISTA COTTON MILL.

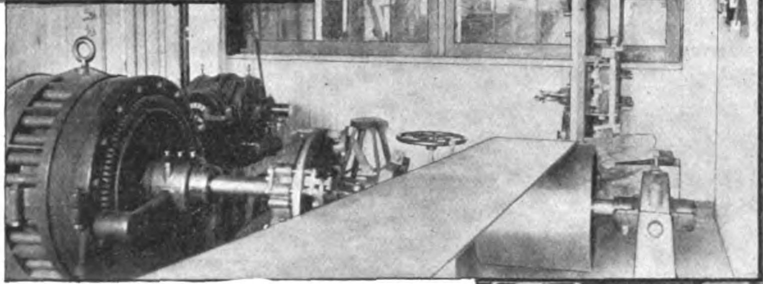


FIG. 9.—80-H.P. SYNCHRONOUS MOTOR IN WOOLEN MILL.

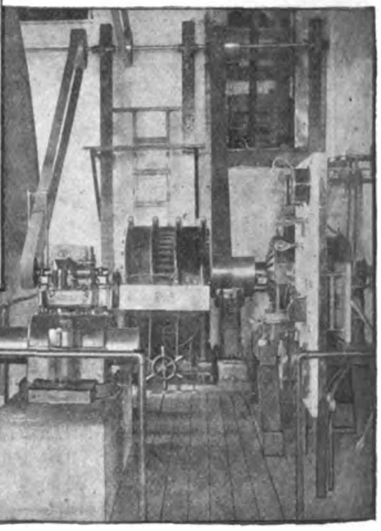


FIG. 10.—300-H.P. SYNCHRONOUS MOTOR AT SOUTH SIDE MILL.

The line is 70,000 ft. in length and extends from the power house to the sub-station in Salem. It consists of three No. 1 soft-drawn copper wires strung on 6-in. triple petticoat porcelain insulators supported on two cross arms. The three wires are 24 ins. apart and form an equilateral triangle, of which the lower cross arm is the base. There are two transpositions in the line, thus giving the triangle two-thirds of a rotation. The line follows the railroad almost all the way to Salem, and the wires are placed on the sides of the pole away from the track to facilitate the stringing of a duplicate set.

The poles are of white cedar and from 36 ft. to 48 ft. long. They are set from 5½ ft. to 6 ft. in the ground and spaced 100 ft. apart, excepting where the line crosses a highway, where they are set 50 ft. apart. Each pole carries three cross arms, the lower two being used for the power circuit. The top arm has six pins. Of these the outer pins carry a barbed wire ground circuit and the inner pins a telephone circuit, which can also be grounded in case of storm. The extra pins are used in transposing the telephone circuit, which is done every 500 ft. At every mile in the length of the line a branch from the telephone circuit is taken down the pole to within a short distance of the ground, so that frequently communications can be had with either end of the line. The barbed wire is grounded every 1000 ft. through a ½-in. galvanized iron pipe driven 10 ft. into the ground at the base of the pole. The poles are all numbered and the line construction is otherwise very complete.

The line enters the sub-station on the second floor and is duly provided with lightning protection, from whence it passes to the main bus bars on the first floor. From these bars three three-pole high-tension circuits are taken through nine single-pole high-tension plug switches. The first of these circuits connects to another set of bus bars, to which the power transformers shown in Fig. 7 are connected three-phase, two sets in parallel. The second high-tension circuit passes through a lightning protection rack and passes to what is known as the fertilizer line. This line is 3½ miles long, and consists of three No. 6 insulated wires, and terminates in a fertilizer works, at which the pressure is reduced by three 25-k.w. oil transformers, to 600 volts, and at that pressure supplies two induction motors, one of 50 h.p. and the other of 30 h.p.

The third high-tension circuit passes through lightning protection and connects with what is called the South Side line. The line is 2½ miles in length, and, like the fertilizing line, consists of three No. 6 insulated wires. It passes at what is known as the South Side mill to three 75-k.w. power transformers, which step down to 600 volts and supply current to a 300-h.p. synchronous motor, shown in Fig. 10, a 10-h.p. induction motor, and three 80-light transformers. The general construction of the second and third high-tension circuits is similar to that of the main line, with the exception of the telephone circuits. It may also be added that the poles are higher, to avoid the city wires.

The primary board in the sub-station is placed about 8 ft. in front of the west wall and parallel therewith. It consists of nine long-handled high-tension switches, having marble bases and mounted on a wooden framework. In the middle leg of the high-tension circuits is placed a Thomson ammeter, mounted on a marble slab.

The collecting board, shown in Fig. 5, is a wooden framework, on which are mounted six double-throw single-pole self-inclosing slide switches. These switches connect the secondaries of the transformers through twelve single-pole porcelain fuse blocks to the 1200-volt bus bars extending to the distributing board. The distributing board shown in Fig. 6 also has a wooden framework, upon which is mounted six 350-ampere single-pole throw switches on marble bases, two Thomson ammeters, two static ground detectors and one Bristol recording voltmeter. From this board two 1200-volt circuits are taken. One supplies current to a 300-h.p. synchronous motor and to two 80-h.p. motors of the same type in the Arista cotton, grain and woolen mills. These are shown in Figs. 8 and 9.

The second circuit supplies current to one 300-h.p. synchronous motor in the Wiston-Salem Electric Station, and to two induction motors of 50 h.p. and 30 h.p. in other shops.

The transformers are of the vertical self-ventilating type. They are ventilated as shown by large iron pipes extending through the roof to a hood about 3 ft. above. The working temperature is however very low and the commercial efficiency is not impaired.

The ground detectors in use throughout are of the static type. The ground wires for the several sets of lightning protectors are of No. 1 copper wire, securely soldered to large copper plates set from 6 ft. to 10 ft. below ground and imbedded in powdered charcoal. The plates are either in naturally wet places or are kept damp by periodically pouring water into a pipe connecting with them.

A duplicate or larger unit and line will shortly be added, as the capacity of the present generator is nearly reached.

Electric Lighting at the Grand Central Depot.

Within the past year the Grand Central Station, which is a Union depot for the New York Central & Hudson River Railroad, the New York, New Haven & Hartford Railroad, and the New York & Harlem Railroad, has been reconstructed with a view to improving its facilities and enlarging its office accommodations. This has necessitated the installation of an entirely new electric light plant, which in some respects differs from standard isolated plant practice, and is therefore interesting.

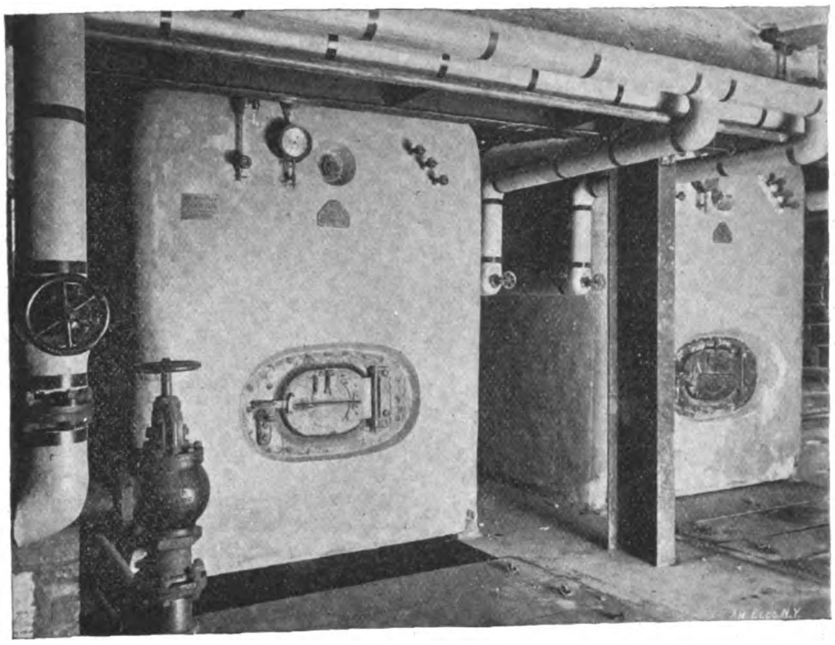


FIG. I.—BOILER ROOM.

One of the unique features of this plant is its boiler room. The space set apart for boilers is very limited and much cut up by foundation pillars and other members of construction. There was no room for boilers of the ordinary water tube type, or even for a customary brick setting used with common cylindrical boilers. The solution of the problem consisted in the installation of six boilers of the locomotive type, built at the Schenectady Locomotive Works. These boilers are worked at a pressure of 125 pounds, at which they can supply sufficient steam to actuate 200 h.p. each in steam engines. The boilers are arranged in a row, and their further ends are united by a long breeching which passes to a 120-ft. stack, 7 in. in diameter. The boilers are heavily sheathed in a magnesia covering, supplied by the H. W. Johns Company, of Brooklyn. The fireboxes are of the regular locomotive type. A spread firing carrying a moderately thick fire is used, and the plant is expected to consume about five tons of broken anthracite coal per day.

In Fig. I is illustrated two of the boiler fronts, and it may be said that this type of boiler is perhaps quite as economical as some of the horizontal cylindrical boilers for stationary work. The expedient has certainly realized the advantage of compact construction in a very high degree.

The boilers themselves are located directly between the abutments of the building, and the space for the firemen in front is under the sidewalk, which is convenient for the delivery of coal and for the handling of ashes, for which a hydraulic lift is provided.

The boilers are fed by two 10 x 5¼ x 10 duplex pumps of the Knowles type. They are supplied with Croton water from a surge tank or from a feed water heater. In addition the boilers are supplied with a Keiley regulator in the main breeching connection, and a butterfly damper in each boiler connection, which is controlled by the firemen.

These boilers deliver their steam to a long header which passes into the engine room. The piping system is not provided for in duplicate. The pipes are covered with the same magnesia covering that is used on the boilers, and are very carefully graded to traps, some of which are of the Keiley and some of the Creamer type. This effectually takes care of the condensation, which is discharged into the feed water heater or blow-off tank as necessity or occasion may require.

The drainage of the steam system is carried to a pump pit below the sewer line and a Braender automatic cellar drainer serves to lift the water into the sewer.

Passing from the boiler the steam enters a large Webster separator and from thence flows into a long header, which runs the entire length of the engine room. This header being of considerable length the expansion has to be allowed for, and this is done by making the taps which pass to the engines with a large loop, thereby much increasing their flexibility and minimizing the strain at the joint between the tap and the header. This arrangement is shown to good advantage in Fig. 2, a picture of one of the units. The steam pipes supplying engines and the elevator pumps are provided with separate separators.

The engines in this plant were made by the Ball & Wood Company. Two of them are single expansion engines of 80 and 120 h.p., respectively. The 80-h.p. engine has cylinder dimensions of 11 x 11, and a speed of 265 r.p.m. The 120-h.p. machine has a speed of 250 r.p.m. and cylinder dimensions of 13½ ins. x 12 ins. There are also two tandem compound Ball & Wood engines 13½ ins. x 22 ins. x 16 ins., capable of developing 240 h.p. at 230 r.p.m. One of these units is the subject of Fig. 2.

The engine foundations are of concrete, and four generating sets are mounted on a single large foundation. The flooring of the engine room is of small hexagonal tiling. The engines are lubricated from a large reservoir on each engine and the feed is by gravity.

Three different provisions are made for the engine exhaust, comprising the station heating system, the feed water heater, or the atmosphere, as required. No condenser is used.

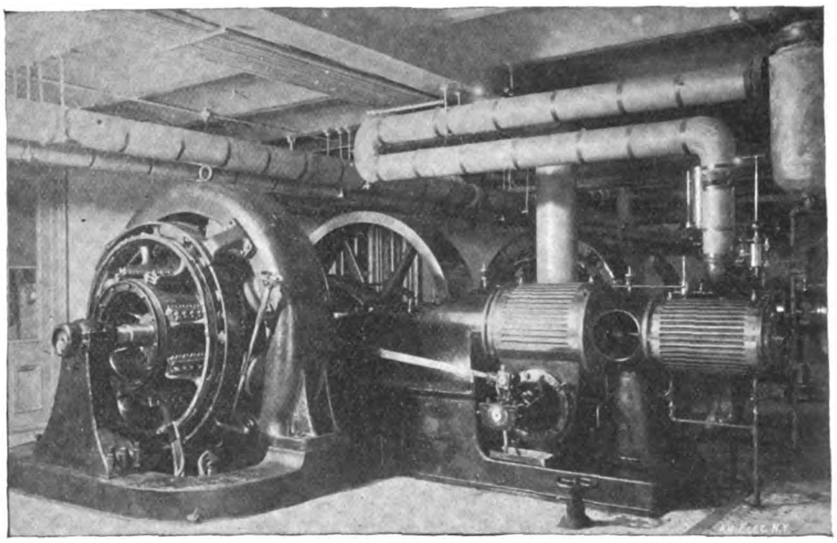


FIG. 2.—150-K.W. GENERATING SET.

The heater is of the Webster make and of 1500-h.p. capacity. The main exhaust is supplied with two grease extractors, but no attempt is made to use exhaust steam for feed water purposes.

There are five dynamos, all of which were made by the Crocker-Wheeler Company, of Ampere, N. J. The two large machines are of 150-k.w. capacity, and can deliver 1200 amperes at the station voltage, which is 125. The two smaller machines are of 75 and 50-k.w. capacity, respectively. All of the dynamos are directly connected to their engines and are therefore of the same speed as the latter. The dynamos, which are the latest Crocker-Wheeler production, have many unique features of design. The field frame is of cast iron, to which the pole-pieces are bolted.

On the inner edge of the field frame is cast a flange, which partly protects the field coils. The magnet is in halves, and is held together by bolts, which pass through flanges on the inner side of the frame, and as the outer surface is filled and rubbed down with great care, the frame looks as though it were all one piece. The pole-pieces are of peculiar shape, which may be best understood by consulting Fig. 6. It will be noticed that the fringing of the field is obtained by making the approach wedge-shaped, instead of gradually increasing the clearance. This is certainly an improvement, for it enables a more accurate adjustment of the stray field, which is a most important matter in commutation.

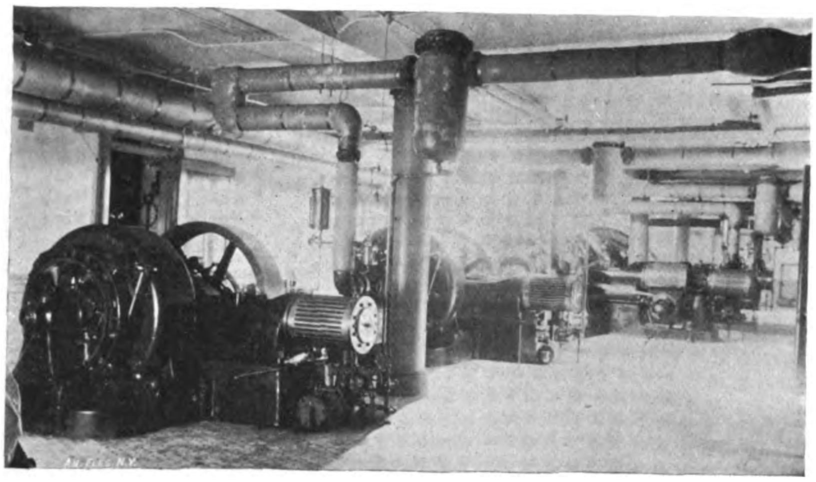


FIG. 3.—MAIN ENGINE ROOM.

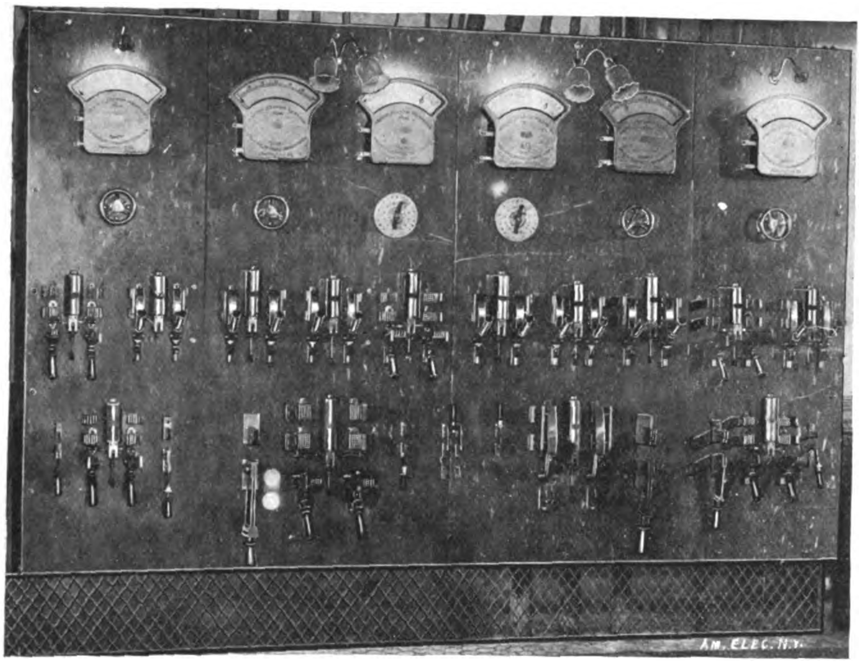


FIG. 4.—SWITCHBOARD.

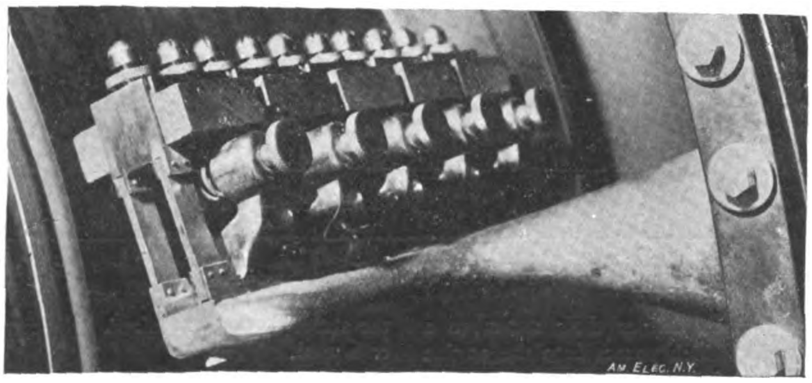


FIG. 5.—IMPROVED BRUSH HOLDER.

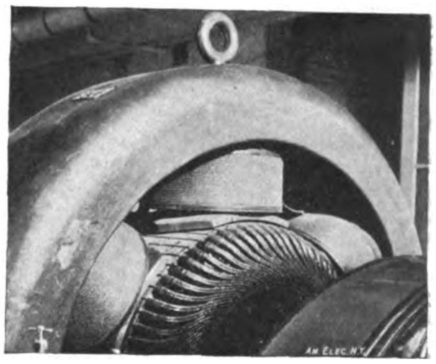


FIG. 6.—SHOWING PECULIAR SHAPE OF POLE PIECES.

The armature diameter of the 50-k.w. machines is 28 ins., the length is 11 ins. The 75-k.w. machine is but little larger, being 32½ x 12½ ins., and the armature dimensions of the 150-k.w. machine are 50 ins. x 16 ins.

The commutator of the smallest machine has 126 bars, that of the next size 111 bars, while the larger machines have commutators containing 192 bars each. The length of the bars on the commutators of these various machines are 6, 10¾, and 13½ ins. respectively.

The brush holders of these machines are worthy of special attention, and are illustrated in Fig. 5. The brush is securely clamped in a brass tube, which in turn is connected with a standard, on which it is mounted, by means of four flexible copper strips. A spiral spring connected between appropriate lugs provides a pressure to force the brush against the commutator, and by lifting on the screw which connects this joint, the brush may be lifted clear of the commutator and latched in that position. A slight turn of this screw suffices to replace it in its operative position once more. The merits of this holder are its simplicity, its convenience and the excellent contact provided from the surface of the brush to the stud. It is a recent creation of the Crocker-Wheeler Company, and is favorably commented upon wherever it has been used.

The output of these generators is controlled and distributed by means of a four-panel switchboard, shown in Fig. 4. The machines are connected by means of double pole switches to a set of bus bars, from which ten distributing circuits take their rise. Each machine is provided with a double pole circuit breaker of the Ward-Leonard type. The output of the machine is measured by means of two Weston voltmeters and four ammeters, two of 400 and two of 1200 amperes capacity. They are of the illuminated dial type. The voltmeters can be connected to the various machines or circuits by means of two Elliott compound voltmeter switches.

The station load is equivalent to 6400 16-c.p. lamps. The building is wired on the two-wire system, with a 7 per cent drop in the lines.

The motor service of the building is very small, consisting of two 1-h.p. motors, used to drive ventilating fans. Almost all of the power is used for lighting.

From the general view of the engine room, shown in Fig. 3, it will be noted that the machinery is not crowded, in which respect this plant is a notable exception to isolated plant practice; but it may be added that compact construction in isolated plant practice is in most cases a necessity rather than a feature of merit in the modern office buildings in crowded city districts.

◆

DEVICES FOR EXPLORING THE POTENTIAL AROUND COMMUTATORS.

BY GEORGE D. SHEPARDSON.

In studying the action of a dynamo or motor, it is sometimes desirable to investigate the relative intensity of the magnetism in different parts of the field, or, what is similar, the voltage between adjacent commutator bars when in different positions. Such investigations are useful in determining the effects of changes in the size or shape of the pole-pieces, the effects of the current in the armature upon the magnetic field, the difference between the armature reactions of a dynamo and of the same machine as a motor, the effects of varying the strength of the current through the field coils; with ring armatures the same method may be used to determine whether the magnetic field is the same on the opposite sides of the armature; also with multipolar machines which are not cross-connected between similar coils of the various circuits, one may determine whether the various parts of the magnetic circuit are equal.

For this purpose a number of methods have been developed, some of which are quite simple. The two methods requiring the least apparatus and also the least skill, are what are often called the single brush and the double brush methods. These require a voltmeter and one or two small brushes which may be moved so as to make contact with the commutator at various positions, while the machine is operating as a dynamo or motor. In the one-brush method one terminal of a voltmeter capable of measuring the total voltage of the machine is connected with one of the regular brushes; the other terminal of the voltmeter is connected with a small auxiliary brush which may be held successively at different positions between the main brushes, as indicated in Fig. 1, in which P and N are the main brushes and b is the auxiliary or exploring brush. By plotting the results, using the various positions of the auxiliary brush and the corresponding readings on the voltmeter, one may obtain a curve which will show to the eye the more or less gradual increase in the voltage from bar to bar.

By connecting the voltmeter between two exploring brushes which are separated the width of one commutator bar and which may be moved to various positions between the main brushes, as suggested in Fig. 2, one may measure the voltage in a single armature coil when in the various positions. Since the voltage in a coil is directly proportional to the rate at which the magnetic lines of force are being crossed or cut, the readings of the voltmeter at the various positions of the pair of brushes are direct indications of the strength of the magnetic field at those points, it being understood of course that the armature is rotating at constant speed.

A number of arrangements have been used for holding the exploring brushes at the different positions desired. An ingenious and simple device was described in the "American Electrician" of March, 1898, page 110, by Professor McKissick, from whose article Fig. 1 is reproduced, and in which may be found examples of curves plotted from the readings taken as indicated above. The device there described involves a considerable outlay for hard rubber, for which vulcanized fibre might be substituted with some less expense and without appreciably affecting accuracy; the fibre is less subject to rotting from the oil, which is liable to make trouble with hard rubber, and the objection of fibre absorbing moisture and swelling may be largely overcome by a coat of shellac.

A somewhat similar device was used in one of the railway shops in Minneapolis, consisting of a ring 9½ ins. in diameter cut from fibre ¼ in. thick. This ring was bored out to an internal diameter of 7 ins. to fit the average commutator, and was then laid out into sixty-four sections, the number of bars in the commutator, and a 3-32-in. hole was drilled through the ring flatwise at each division. One hole was drilled radially through the ring so as to allow a No. 11 wire to fit snugly and yet be free to move in and out. A wire spring pressed this wire against the commutator. A pin passing through any one of the sixty-four holes in the ring and also through a clamp attached to one of the brush-holders, allowed the ring to be rotated one step at a time, so that the short radial wire or exploring brush could be placed in any desired position.

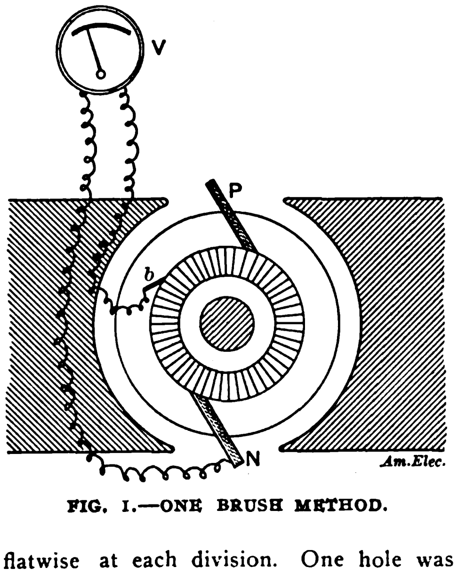


FIG. 1.—ONE BRUSH METHOD.

Another device differing from the above was also designed, consisting of a ring turned from hard fibre one-half inch thick and bored out to fit the average diameter of the commutators. The ring was then laid out into as many sections as there were commutator bars, and a 1-16-in. hole was drilled radially through the ring at each division. The ring was then split for easy placing on the commutator, a soft rubber band stretched around the outside serving to hold it together and also to press a short piece of pointed wire through one of the holes so as to touch the commutator. Suitable clamps held the ring from moving. One terminal of the voltmeter was then connected with one of the regular brushes of the motor, the other terminal being connected by a flexible wire to the short piece of wire which could be placed in any of the radial holes in the ring, so as to make contact with the commutator at any desired point.

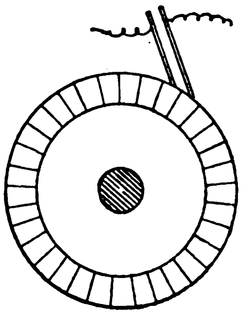


FIG. 2.—TWO BRUSH METHOD.

A still simpler, but less accurate scheme, suitable for machines having two or more brushes on a side, is to slip a narrow strip of stout paper under one brush and stretch it around the commutator to the corresponding brush on the opposite side. Then, while the machine is standing still, make a pencil mark on the paper directly opposite the mica insulation between the commutator bars. Now put the machine to work, and if the paper has been properly fastened, it will stay in place long enough for the experiment. The exploring brush may be simply a wire (No. 16 or larger) filed to a sharp point, which is held in the hand opposite one pencil mark at a time. This method requires two experimenters, one to hold the wire and the other to read the voltmeter. The two-brush method may be used with this "apparatus," it it may be so dignified, by fastening two wires together so that the points shall be apart the width of a commutator bar and mica; the two wires are then handled as one, the voltmeter being connected between the further ends of the two wires.

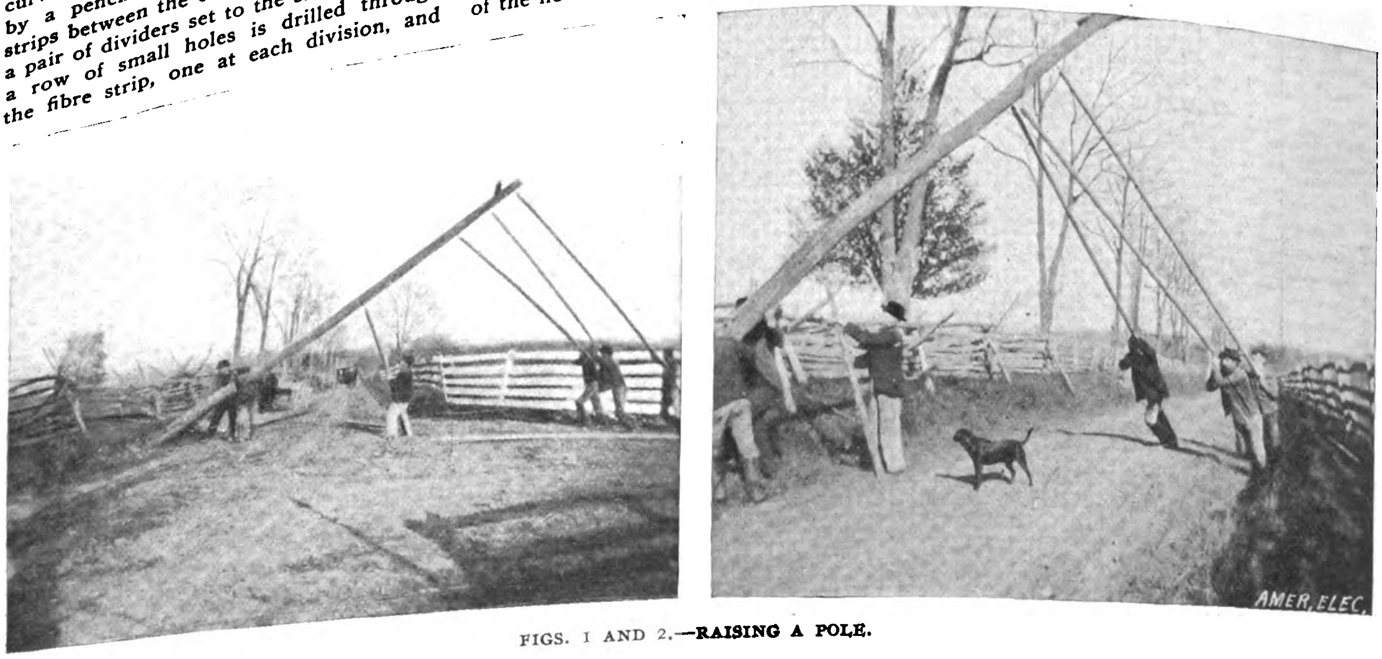
A more durable and more accurate device has been in use for some time in the electrical laboratory of the University of Minnesota, giving so much satisfaction for easy manipulation, accurate results and low first cost, that a description may be of interest to others. A strip of hard fibre 1-16 in. thick, ¼ or ⅜ in. wide, and long enough to reach a little more than half way around the commutator, is soaked in water until quite soft. A strip of oiled paper is then wrapped around the commutator to protect it from the moisture. The softened hard fibre is then wrapped around the commutator and tied closely, so that in drying it will take the curvature of the commutator. In a few hours the fibre will have become dry and hard so that it will retain its proper curvature. The fibre strip is now marked by a pencil or knife opposite the mica strips between the commutator bars, or by a pair of dividers set to the same distance; a row of small holes is drilled through the fibre strip, one at each division, and the holes are numbered with a pen or, preferably, with steel stamps. A larger hole is drilled at each end of the strip, into which a hard cord or wire is fastened. A thin coating of graphite or hard grease is then smeared over the inside of the ring so as to lubricate it sufficiently to prevent it from binding upon the commutator, and the outfit is ready for use.

This simple strip of fibre with a row of holes and a cord at one or both ends constitutes the exploring device. It may be placed in position while the machine is running, and may be removed without disturbance. When placing in position for use, the strip is sprung over the commutator and one of the cords is fastened to some convenient part of the machine below the commutator so that the cord holds the strip against the tendency toward being pulled around with the commutator. The length of the cord is adjusted so that one of the holes comes opposite the toe of one of the brushes, and the other cord is tied down so as to keep the fibre strip from moving sidewise. The potential around the commutator may now be explored by either the single or double-brush method, the end of the wire being held against the commutator through the holes. The whole operation of adjusting, taking readings and removing the apparatus requires little more than half an hour, even for a novice.

ERECTING A HIGH VOLTAGE TRANSMISSION LINE—III.

BY S. H. DAILEY.

The set of raising tools consists of 2 pike poles, 12 ft. long; 3 pike poles, 14 ft. long; 1 dead man, 6 ft. long; 1 dead man, 8 ft. long; 2 tamping tools; 1 short handle shovel; 1 crowbar, 8 ft. long; 1 cant hook; 1 monkey wrench, 12-in.; 1 hand axe. The pike pole, dead man and tamping tool are shown in Fig. 5.



FIGS. 1 AND 2.—RAISING A POLE.

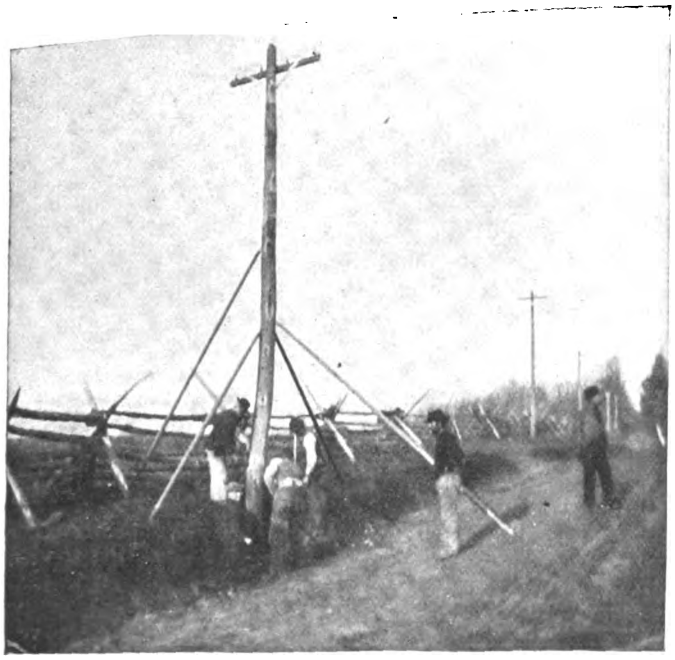


FIG. 3.—POLE RAISED.

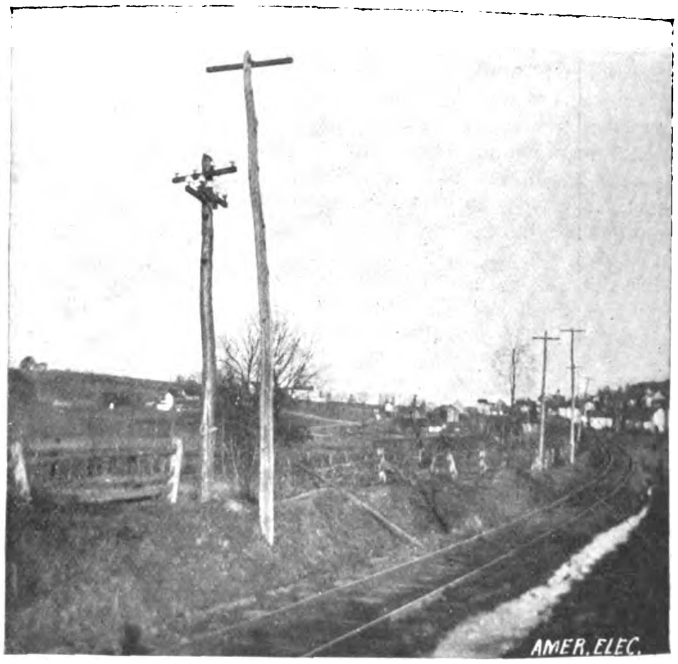


FIG. 4.—REVERSE TURN.

It is understood that the same gang that did the digging is to raise the poles, so select the shortest man to man the "dead man" and four of the heaviest to do the "piking," the remaining man to place himself at the butt of the pole to help steady it from swinging, and also direct the pikers as to whether or not the butt is entering as it should.

First, take the pole and place it so that the tip is up hill and the butt is over the hole, pushed up against the crowbar, which should have been set in the hole and against which the pole slides, to prevent it from plowing into the ground. If the pole should have been placed any great distance from the hole, it can be easily slid to it by rolling the butt on a shovel and all hands lifting at the top and pushing together.

Now take all hands but the one manning the dead man and lift the tip of the pole high enough to set the dead man under it, being careful to have the dead man slant toward the butt so as to prevent the weight of the pole from slipping it out. Continue lifting and working the dead man toward the butt till the pole is high enough to allow the two short pikes to get a hold.

Here a few words about piking will not go amiss, as there is a knack in it like all other work. The pike should be firmly set in the pole at such a point as will allow of getting a good push on the butt end, which should be placed against the shoulder. Keep the men as near directly under the pole as possible, spreading only enough to insure steadiness in keeping the pole from swinging. Fig. 3 shows a gang of men raising a 30-ft. pole. The piking should be steady and all the gang pushing together until the pikes are out of reach; then one should call out "high pike," then change the pikes to a lower hold, one at a time, alternating from side to side, so that the weight will not come all on the same side at once. In changing pikes to a lower hold be sure that the "dead man" is set firm and taking its share of the weight. As soon as the pole is high enough to allow using the other pike poles, let the other men take a hand at it and send the pole in the hole.

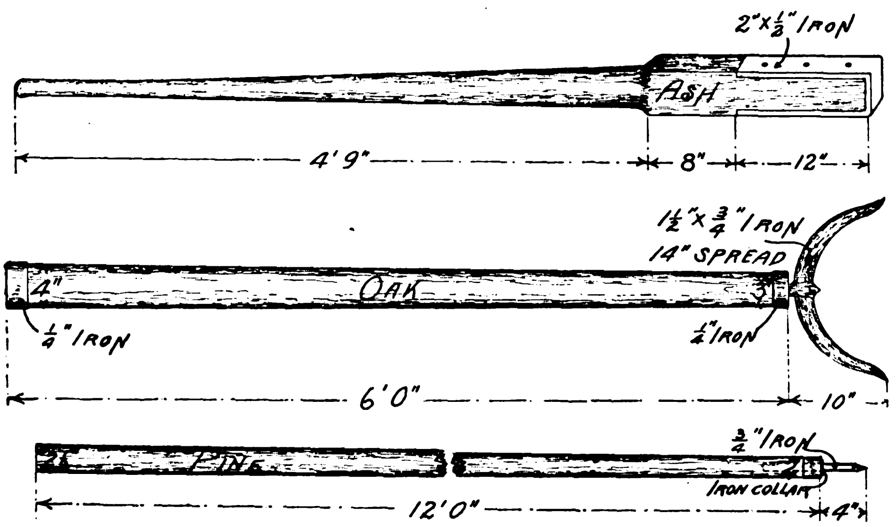


FIG. 5.—PIKE POLE, DEAD MAN, AND TAMPING TOOL.

Now place four pike poles around it with a man at each to steady it, and turn the pole around with the cant hook till the arm faces in the right direction; line it up so that the arm sets horizontally and the pole is vertically in line with those already set. Along comparatively level ground turn the arms so that two are facing each other, the next two back to back, and on a hill face all arms up hill; this will insure the best wear by distributing the pull from the weight of the wire evenly.

When the pole is lined satisfactorily, "ground" the pikes, Fig. 3, and tamp the ground well around the pole as the hole is being filled up. A few stones thrown in will help to make it more secure.

Poles which are out of line or on turns should be anchored at the heel with heavy stones on the opposite side from the direction of the strain, and keyed at the top or level of the ground on the other side.

The average time of raising a pole and tamping it should not be more than fifteen minutes, thus making twenty in a half day, or as many as there were holes dug for in the morning. If it becomes necessary to set a pole in a place where the hole is filled with water from a neighboring stream, put nothing but stones around it to a height level with the water, then fill the rest with ground. Press the ground well up around the pole to allow for settling, which after a few months will be down to an even surface with the surrounding ground.

The importance of properly guying all poles in a high voltage transmission line cannot have too much attention.

In the May issue of this paper, Fig. 3 shows the manner of attaching the guy, generally a ¼-in. or ⅜-in. stranded steel cable. The ends are held in place by clamps made for that purpose, consisting of two oblong pieces of galvanized iron with grooves cut in lengthwise to fit the cable, and held together by bolts, which when screwed up clamp the cable.

The guy stub should be of such a height as to keep the cable high enough not to interfere with road travel. For the anchor of the stub use a heavy stone, around which fasten the cable, and just above the surface of the ground fix a loop in this cable, as shown in the cut. On top of the anchor stone pile as many stones as you think sufficient to make the anchorage solid and cover all with dirt even with the surface. A convenient method of taking up the slack in guys is by placing a turnbuckle in the guy at the loop just above the ground, as this may be tightened up at any time necessary without unfastening the clamps. When it is found convenient to use a tree for a guy to be fastened to, be sure to place strips of wood between the guy wire and tree, which will prevent the wire from cutting into the tree.

In cases where the strain is not very severe on a pole, the cost of guying can be reduced by using two strands of solid No. 8 galvanized wire, twisted. To twist this, fasten the two ends to one pole and the other two to another pole, separated the required distance, leaving enough slack to be taken up with the twist; then twist them together by using a stout stick placed in the middle of the span between the wires.

Do not forget to erect the guy stub and place the anchor stones when the poles are being set, thus being able to do away with carrying and raising tools along when stringing wires. The guy wires from the pole to guy stub may be put on when erecting, but do not clamp them permanently, as they would have to be taken down again to get the line wire on the poles.

Ground wires to connect with the barb wire for lightning arresters should be placed on every twelfth pole, or one-half a mile apart. For this use solid No. 8 galvanized wire and fasten on the pole before raising up by staples, leaving 18 ins. over top of pole; on the bottom curl it up in a spiral of about 8 or 10 turns, also fastened with staples. The damper the hole the better will be the ground.

There will be cases where the lines must make a turn at an angle approaching 90 deg., or a right angle, and for this purpose a reverse turn must be made in order to keep the wires sufficiently far apart. To accomplish this, the cross arms are set at an angle equal to that of the turn and double arms used, one on each side of the pole, which, together with the usual braces are made secure from wabbling by being bolted together on the ends, having a block of wood between them through which the bolt passes.

The art of climbing can only be acquired by continual and persistent practice and for which there are no set rules, as every one has his own peculiar style; so the best way to learn it is to purchase a pair of climbers and start in. A few points, however, to a beginner, may be of some help: Do not strap the climbers on too tightly, and in beginning be sure to keep the knees well out from the pole to prevent the spike from "cutting out." Take small steps, keeping the body well away from the pole; and when it is desired to remain for a time in any place on the pole, stand on one spur only, with the other leg thrown around the pole.

Climbers can be purchased of any supply house, costing about $4.00, complete with straps.

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ELECTRICAL COMBINATION LOCKS.

The possibilities of electrical combination locks for cash drawers and similar receptacles does not seem to have been realized to its fullest extent. It requires but little ingenuity to arrange four or five push buttons in such a way that only one combination will close the circuit of an unlocking magnet, and any other will ring an alarm. The alarm could be placed at any convenient point, and at other points could be placed cut-out switches which, when manipulated, would render it impossible even for one who knew the combination to succeed in opening it. The device is easily developed and marketable.

WINDINGS OF MULTIPHASE ARMATURES.

BY J. P. STONE.

Thus far we have treated entirely of coil windings, but for low voltages a bar winding is often used, especially on large machines, as this permits of getting a greater amount of copper in a given space than a coil winding, so, when the number of turns necessary to produce a given potential will allow of it the bar winding is often found preferable.

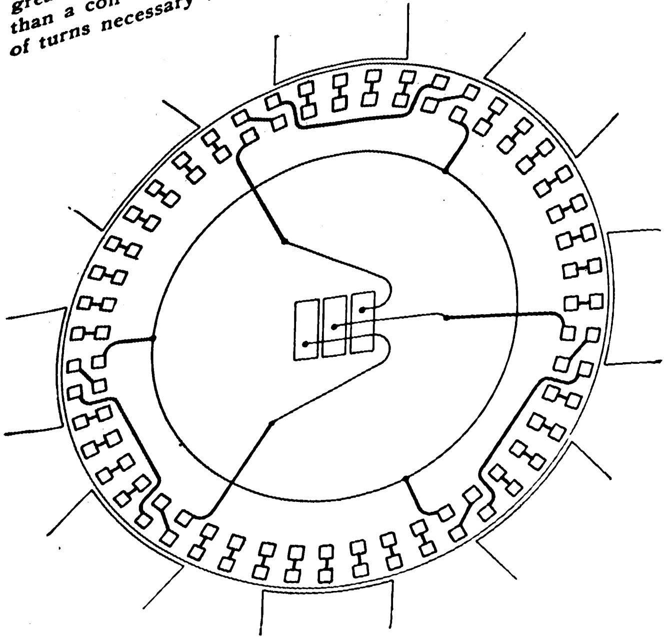


FIG. 12.—THREE-PHASE BAR WINDING; END VIEW OF CONNECTIONS.

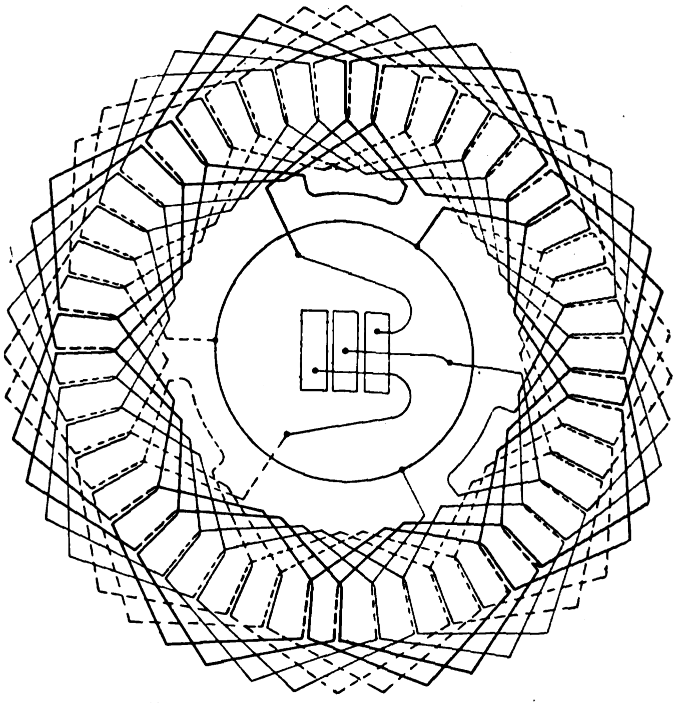


FIG. 14.—THREE-PHASE BAR WINDING, HAVING TWO SLOTS PER POLE PER PHASE.

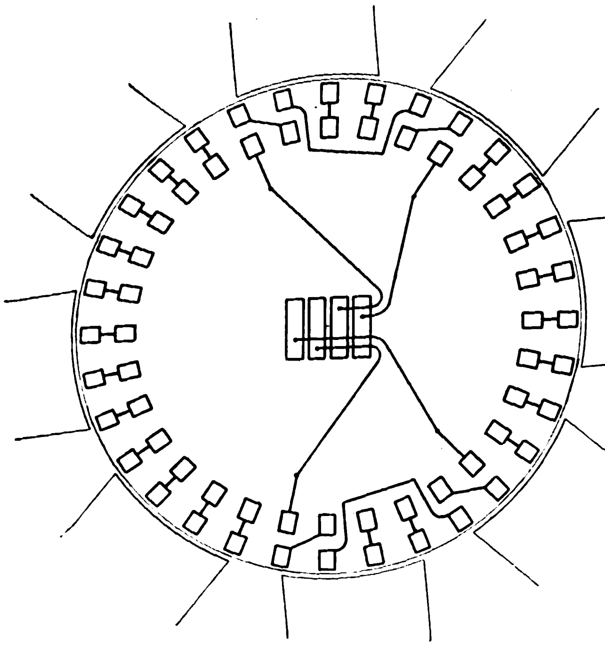


FIG. 15.—QUARTER-PHASE BAR WINDING, HAVING TWO SLOTS PER POLE PER PHASE.

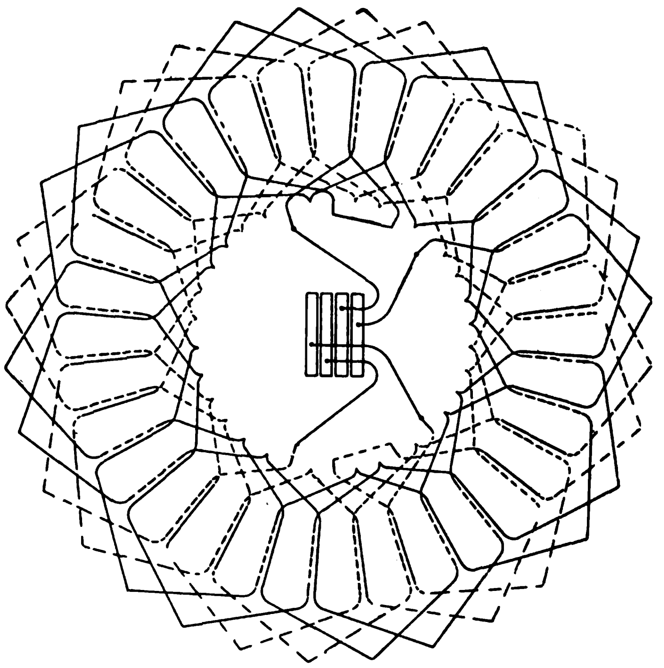


FIG. 13.—QUARTER-PHASE BAR WINDING; END VIEW OF CONNECTIONS.

A bar winding is best made in the form of a drum winding, and is made similar to the coil winding, two bars forming a turn similar to the coil winding. A bar winding can be made either as a lap winding, as shown in Fig. 12, or as a wave winding, as shown in Fig. 13, but as the wave winding has many advantages over the lap winding the latter will not be shown, as it is not extensively used in alternating-current work. In the wave winding the circuit progresses around the armature in a series of waves, as shown in Fig. 22.

A three-phase bar winding is shown in Figs. 12 and 14, having two slots per pole piece per phase and two bars per slot.

As will be seen from the diagram (Fig. 16), the ends of the bars which project beyond the slots on the ends of the armature are bent so as to form connections that would correspond to the ends of coils on a coil-wound armature. As the upper and lower bars which form sides of a coil each reach half way across, they are simply joined by a clip.

All the top bars in the slots on one end of the armature have their ends bent in one direction, and all the bottom bars in the same slots have their ends bent in the opposite direction; and as each bar, or conductor, spans half the distance between the slots, all that is necessary to complete the turns being to join the ends of two bars which are directly over each other by means of a clip, as shown in Figs. 17 and 12.

Fig. 17 shows a bar-wound armature with all the conductors in place.

On the other end, as shown in Fig. 15, special connecting pieces are required.

On the other end, as shown in Fig. 12, 14), the winding progresses twice around the armature in one direction, then reverses and goes twice around the armature in the opposite direction, thus going around before reversing as many times as there are slots per pole piece per phase, the two bars per slot being shown in the diagram side by side, whereas in the armature they are placed one above the other. The same winding is shown connected for quarter-phase in Figs. 13 and 15.

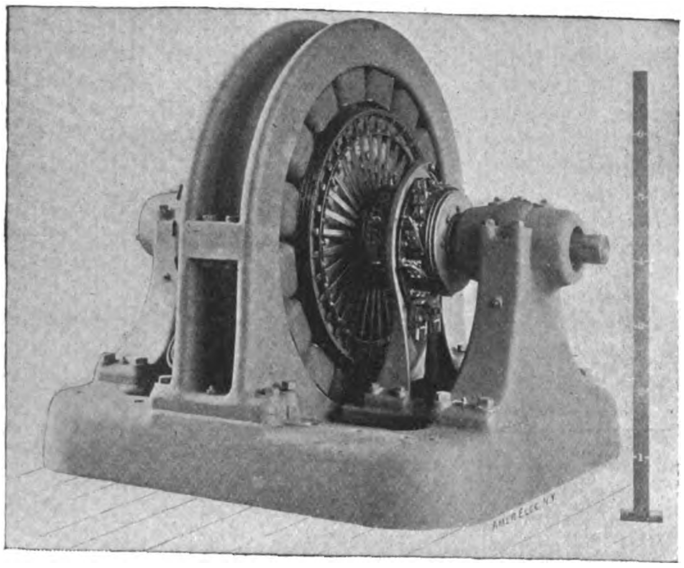


FIG. 16.—COLLECTOR SIDE OF ROTARY CONVERTER, SHOWING LEADS TO COLLECTING RINGS.

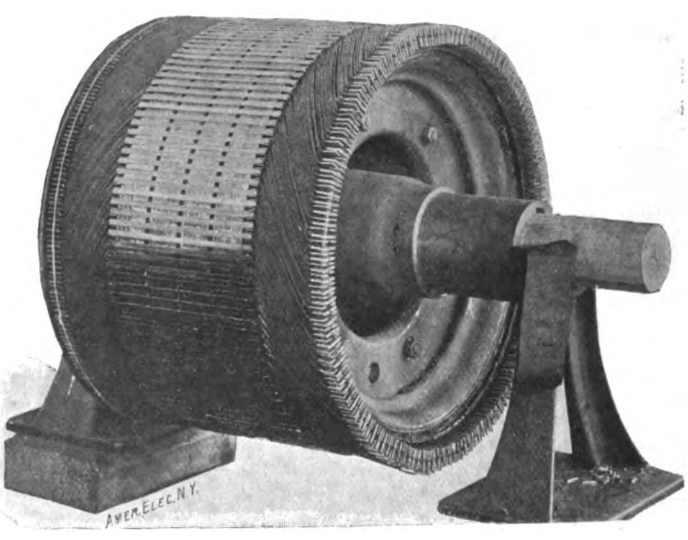


FIG. 17.—BAR WOUND DRUM ARMATURE, WITH ALL THE WINDINGS IN PLACE.

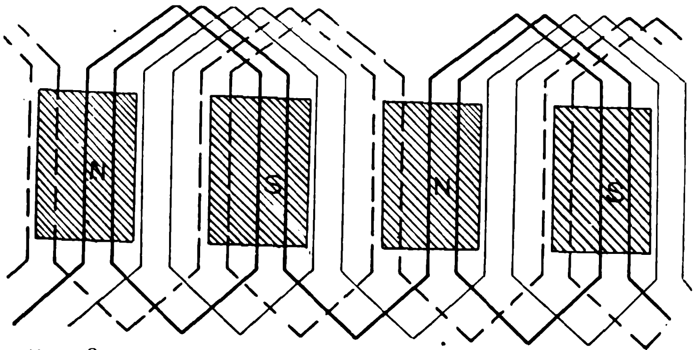


FIG. 18.—THREE-PHASE LAP WINDING WITH TWO SLOTS PER POLE PER PHASE.

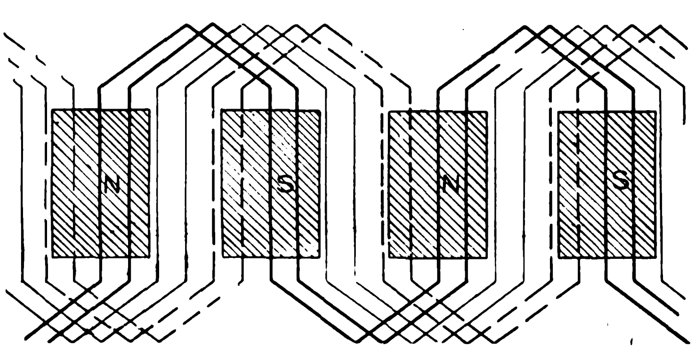


FIG. 19.—THREE-PHASE WAVE WINDING WITH TWO SLOTS PER POLE PER PHASE.

In the above diagrams full-pitch windings have been shown, that is. the spread of a coil (or the two bars corresponding to a coil) is the distance between the centers of two pole pieces. If it is less than this it is a fractional or minus pitch (as a —1, —2, —3 pitch winding), or if more is a plus pitch (as a +1, +2, or +3 pitch winding).

In a similar way a winding can be laid out for any number of slots per pole piece per phase.

A completed polyphase armature is shown in Fig. 21, having a drum winding.

The windings just described can be also laid out for an odd number of slots, and wound with either bars or coils, and are by some thought to possess advantages for certain classes of work when made this way.

The drum winding here described as used for alternating armatures is similar to the drum winding used in direct-current machines, which latter differ only in having a greater number of slots, and not being connected in separate phases, but in a continuous closed circuit, the clip joining the bars on the front end of the armature being extended down and soldered into commutator segments.

In rotary converters which combine alternating with direct current a regular continuous-current drum winding (which may be either bar or coil, as best suits the conditions of each particular case) is used, and taps are brought out at the proper points and connected to the collector rings,

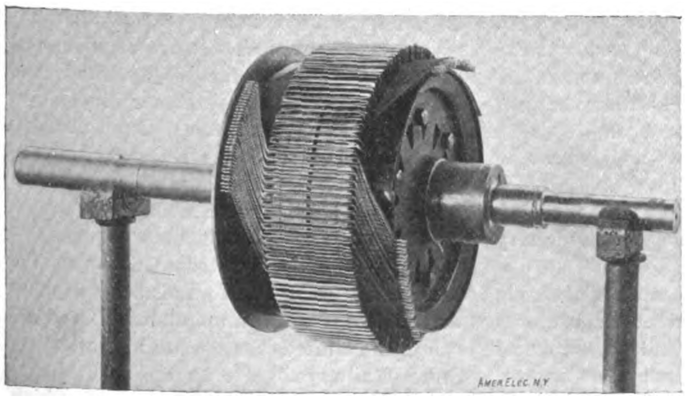


FIG. 20.—BAR WOUND DRUM ARMATURE, PARTLY WOUND.

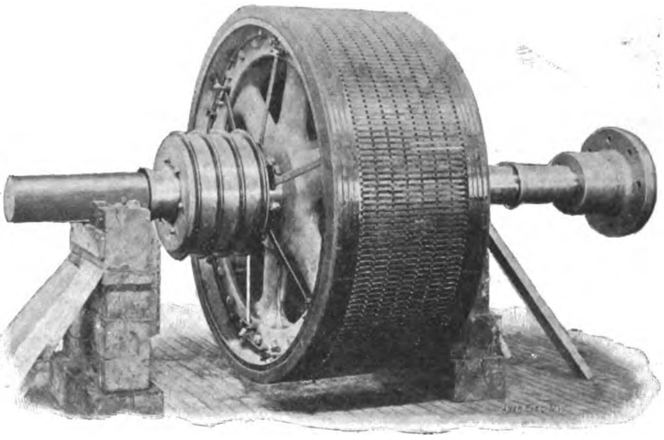


FIG. 21.—COMPLETED POLYPHASE ARMATURE.

as shown in Fig. 16, there being as many leads or taps to each ring as there are pairs of poles, these leads being connected to the winding at points equally distant from each other, all around the armature.

Thus, in general, many of the continuous-current armature windings may be employed for alternating-current work, but the special considerations leading to the use of alternating currents generally make it necessary to abandon the styles of winding best suited to continuous-current work and to use windings specially adapted to the conditions of alternating-current practice.

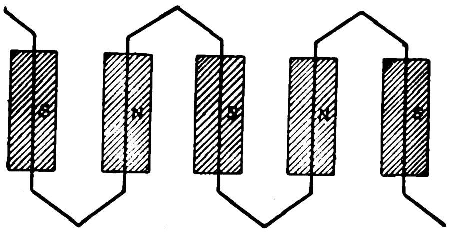


FIG. 22.—WAVE WINDING.

But all the closed-circuit continuous-current windings are of a necessity two-circuit or multiple-circuit windings; while alternating-current armatures may, and with the exception of rotary converters and delta-connected three-phase machines almost always do from practical considerations have a one (or single) circuit winding (one circuit per phase). From this it follows that any continuous-current winding may be used for alternating-current work, but the reverse is not true; that is, alternating-current windings cannot generally be used for continuous-current work. In other words, the windings of alternating-current armatures are open-circuit windings, with the exception of the ring Δ-connected polyphase windings, which are closed-circuit windings. These latter are, therefore, the only windings which are applicable to continuous-current work, and are used on rotary converters and similar machines which combine alternating and continuous currents.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

The seventeenth annual meeting of the Street Railway Association convened at the hall of the Massachusetts Charitable Mechanics' Association, and was in session from September 6 to September 9. The building was exceptionally well suited for this meeting and was provided with an excellent amphitheatre, which was just large enough to hold the exhibits, and contained admirable facilities for the evening entertainments. The exhibits were very complete, and the efforts of the supply men to display to the street railway officials details of their latest practice was highly commendable. The attendance was large and enthusiastic, and interest was shown both in the meetings and in the inspection of the exhibits.

TUESDAY, SEPTEMBER 6.

The meeting was called to order at 11 o'clock in Paul Revere Hall, by President A. E. Lang, who introduced Mayor Josiah Quincy of Boston. The Mayor delivered an address of welcome, in which he recognized and discussed the importance of the advance and development of electrical transportation.

After thanking the Mayor for his kindly interest thus cordially expressed, President Lang read his annual address, in which he traced the history of the Association from its birth, and referred briefly to the various meetings, reviving some pleasant remembrance in the case of each one. He thanked the technical press, the supply men and the Executive Committee for their efforts in behalf of the Association. He also suggested a few suitable subjects for future papers and discussions, and in closing called attention to the Street Railway Accountants' Association, which held its meeting simultaneously with the Street Railway Association every year, and which was even then in session in another part of the building. He recommended that these two associations endeavor to be in close touch, as their interests were largely identical. In closing, he thanked the secretary, the Excutive Committee and the members of the Association for their support, and expressed his appreciation of the honor of being called to the office to which he was unanimously elected a year ago.

Following the president's address a vote of thanks was tendered to the Mayor of Boston, after which the report of the Executive Committee was read by the secretary and approved.

A report on the relative merits of single and double trucks for street-car use was read by Mr. Richard McCulloch, electrical engineer for the Cass Avenue and Citizens' Street Railway Company, St. Louis, Mo. The conclusion of the writer seemed to be that he considered the cost per passenger, of wear and tear on the trucks and motors, and the power required, was about the same on a single or double truck car. Passengers, however, seemed to express a general preference for the double truck cars, due to the improvements in the lowering of the steps and their easier riding. In general, he considered that the double truck car was more suitable for long haul, high speed pleasure travel, and for lines competing with other systems, while the single truck car is better for dense traffic, many stops and slow speed.

In the discussion which followed, Mr. Beggs, of Milwaukee, spoke favorably of double truck cars, and stated that the performance of the double truck on the Milwaukee & Waukesha line had confirmed him in the opinion that the four-motor double truck equipment is very desirable.

It was suggested that all members of the Association who were present at its organization in Boston in 1882 should rise, and the following gentlemen rose: Messrs. W. W. Bean, of St. Joseph, Mich.; George B. Kerper, of Dayton, Ohio, and Julius E. Rugg, of Boston. The meeting then adjourned.

MR. CHARLES S. SERGEANT,
PRESIDENT OF THE AMERICAN STREET RAILWAY ASSOCIATION.

In the afternoon the Massachusetts Charitable Mechanics' Association provided an entertainment in the shape of a trip to Lexington and Concord. Various historical points along that route were visited, and many others of lesser interest pointed out. In the evening the Ladies' Committee of the Massachusetts Street Railway Association arranged a reception and dance, which was held in Paul Revere Hall.

WEDNESDAY, SEPTEMBER 7.

The meeting was called to order by the president at 10:30 A. M., and the first paper was read by W. S. Dimmock ,on "The Carrying of United States Mail Matter on Street Railways." He spoke of the benefits to the Post Office Department which pertained to electric car service, and called attention to the fact that the electric mail cars experienced fewer delays and interferences on the route. He considered that the compensation for this service was altogether too small, and that the electric railroads counted too much on the protection granted against interference of strikers, and consequently had taken the mails at almost any price. The present flat rates paid by the Government of three cents per mile for pouch service, and sixteen cents per mile for 16-ft. cars, he considered too low, and it was suggested that the members use what influence they could toward getting the Government to increase these rates.

In the discussion of this paper, Mr. C. S. Sergeant, of Boston, gave some interesting details of the mail system there in use. After further discussion it was moved and seconded that a committee of five be appointed by the chair, to act under the Executive Committee and communicate with the different members of the Association to collect facts and keep the Association advised of their proceedings, and to have authority to confer with the post office officials. The motion was carried.

The next paper was that of Mr. M. S. Hopkins, on "The Maintenance and Equipment of Electric Cars for Street Railways." The paper discussed the choice of car bodies, trucks and electric equipment. Referring to maintenance, he said that the character of the man who operated the cars, the manner of operation, the way in which repairs were made, and the material used are controllable elements, and, in many instances, the chief features affecting the cost of maintenance. He spoke of the care and equipment of car houses at considerable length, going into considerable detail. He advocated the use of oil as a lubricant on armature and axle brasses as being more satisfactory and economical, and stated that under ordinary conditions six months was the average life of a babbitt or brass bearing on a street railway motor. He strongly recommended the use of phosphor bronze for bearing brasses, and that street railway men cast their own bearing shells. Speaking of commutators, he recommended soft, close grained carbon brushes treated with good lubricating compound, pressed against the commutator with strong tension, stronger than is ordinarily used.

He advocated amber mica in commutator construction, stating that hard, clear mica would not wear away as fast as the copper, thereby producing imperfect contact. Referring to tests, he considered that the practical value of elaborate testing systems had not been fully demonstrated, and that tests should only be made when motors were not working properly. For testing systems he recommended a portable Wheatstone bridge testing-set, capable of showing a variation in resistance of 1-1000 of an ohm, and a first class magneto as all that was necessary.

A vote of thanks was tendered to Mr. Hopkins for his paper, after which Mr. W. Caryl Ely, first vice-president of the Street Railway Association of the State of New York, extended an invitation to the members of the National Association to attend the annual convention of the New York State Street Railway Association at Manhattan Beach, on Tuesday and Wednesday, September 13 and 14. Letters of invitation to the Association to hold meetings in various cities next year were presented by delegates, and a committee on nominations was appointed by the president. The meeting then adjourned.

In the afternoon the delegates quite generally attended an excursion to Nantasket Beach.

THURSDAY, SEPTEMBER 8.

The meeting was called to order by the president at 10:30 A. M. The first paper read was that by Mr. W. H. Holmes, who took for his subject, "To What Extent Should Railway Companies Engage in the Amusement Business?" The writer seemed to think that street railway companies should confine themselves to the provision of ample means of communication with public places of amusement, rather than creating them. The maintenance of such enterprises bv street railway companies has generally been found to be ill-advised and unprofitable, except in places where more than a five cent fare could be collected. The author's experience in this line in Kansas City was described, and as the result of the investment they abandoned this line of work, and provided transportation to parks maintained by independent corporations, the company paying these corporations a fixed sum for giving its patrons the privilege of the parks. The company has given financial aid to various festivities which have occurred in Kansas City, which sums the author considered was well spent.

Quite a general discussion followed this paper, the opinions being closely divided. At the conclusion of the discussion the report of the nominating committee was read, as follows:

For president, Charles S. Sergeant, second vice-president Boston Elevated Railway Company, Boston.

For first vice-president, Henry C. Moore, president Trenton Street Railway Company, Trenton, N. J.

For second vice-president, Ernest Woodruff, president Atlanta Consolidated Street Railway Company, Atlanta, Ga.

Third vice-president, Walton N. Holmes, general manager Kansas City Railway Company, Kansas City, Mo.

Secretary and treasurer, Thomas C. Penington, treasurer Chicago City Railway Company, Chicago, Ill.

Executive Committee:

Albion E. Lang, president Toledo Traction Companv, Toledo, Ohio.

George E. Yuille, second vice-president of the West Chicago Street Railway Company, Chicago, Ill.

Frank Jones, president Memphis Street Railway Company, Memphis, Tenn.

John I. Beggs, general manager Milwaukee Railway & Light Company, Milwaukee, Wis.

Ira McCormack, general superintendent Brooklyn Heights Railway Company, Brooklyn, N. Y.

A unanimous ballot was then cast for the gentlemen nominated, and Chicago, Ill., was chosen for the next place of meeting.

An invitation from the Boston Elevated Railway Company to the delegates invited them to visit any of the power houses, shops or car houses of the company, stating that particular attention would be shown to visitors.

The privileges of the floor were then granted to Mr. T. Y. Dzushi, Chief of Finance and Manager of Stores of the Imperial Government Railways of Japan, and to Mr. K. Sugahara, the chief engineer of several street railroads which are soon to be built in that country. The latter gentleman spoke on the street railway systems of Japan, and stated that they were in embryo state as yet. Electric traffic has been greatly interfered with by the use of the jinrikisha, and by other types of vehicles drawn by men, aggregating some 130,000. Several electric railways, however, have been proposed. At present there are only 60 miles of track in use, and most of this trackage is operated by horse-power.

A paper was then read by Mr. Fred D. Perkins on "The Inspection and Testing of Motors and Car Equipment by Street Railway Companies. This paper was on a similar line to that of Mr. Hopkins' of the day before, but was of a more specific nature, and discussed at length the best methods of caring for street railway equipments, repairing and testing them. Owing to lack of time there was no discussion on this paper. The meeting then adjourned.

In the afternoon the delegates attended an excursion to Plymouth and visited the historic points in that town and the National monument to the Pilgrim Fathers. In the evening a banquet was held at the Brunswick Hotel, and was attended by nearly 350 people, including many ladies.

FRIDAY, SEPTEMBER 9.

The meeting was called to order at 10:40 A. M. Mr. R. W. Conant read a paper on "The Cost of Electric Power for Street Railways at the Switchboard," which was briefly discussed.

The newly appointed president was introduced by the retiring president, and took the chair. Mr. Sergeant spoke, thanking the Association for his appointment, and promising to do everything in his power to further its interests, and to benefit street railways. The Association then adjourned.

In the afternoon a trip was taken to Norumbega Park in Auburndale, which was reached by a trolley line extending through the handsomest part of Boston's suburban district.

CONSOLIDATION OF THE WESTINGHOUSE AND WALKER COMPANIES.

On Friday evening, Sept. 16, the final papers were signed for the consolidation of the Westinghouse Electric & Manufacturing Company and the Walker Company. In connection with this transaction the following statement has been issued by George Westinghouse, Jr., president of the Westinghouse Company:

"The election this day of Roswell P. Flower and Anthony N. Brady as members of the board of directors of the Westinghouse Electric & Manufacturing Company to represent the interests of the former stockholders of the Walker Company, completes the union of the interests of the Walker Company, of Cleveland, with those of the Westinghouse Electric & Manufacturing Company. The purchase of the Westinghouse Company includes substantially all of the outstanding stock and all but $850,000 of the $2,500,000 of the twenty-year bonds of the Walker Company, the $850,000 remaining a first lien upon the property. The recent sale by the Westinghouse Company of $3,000,000 of debenture certificates has erroneously been connected with this transaction. The entire proceeds of the sale of these debenture certificates were used in retiring the floating and other debt of the company, as previously announced.

"The increase in the total yearly fixed charges of the Westinghouse Company, due to the purchase of the Walker Company, will be but a little more than the sum that the Walker Company has been expending annually in defending patent litigation instituted by the General Electric and the Westinghouse companies. The acquisition of the Walker Company will, by reason of the agreement of March 31, 1896, between the General Electric and Westinghouse companies, put an end to this patent litigation and very large annual expenditure on both sides. The business of the Walker Company, as a controlled company of the Westinghouse Company, will be entitled to the protection of the patents of the Westinghouse and General Electric companies, and will in all respects be subject to the agreement between these two companies in relation to patents.

"The Westinghouse Company regards the business and good will of the Walker Company as a valuable acquisition, especially as the Walker Company brings with it upward of $1,250,000 unfilled orders. The Walker Company has at Cleveland modern and extensive works, equipped with machinery capable of manufacturing the largest type of railway apparatus, and will, with the works of the Westinghouse Company at East Pittsburgh, constitute a manufacturing plant second to none in the country. The capacity and profits of the two companies will be increased by carefully harmonizing the manufacturing and selling operations, and the direct savings thereby effected should exceed the fixed charges incurred by the purchase of the Walker Company. The shipments of both companies, owing to the large orders on hand, have been increasing during the past few months, and exceeded $750,000 for August.

"The total fixed charges of the Westinghouse Company, including those due to the Walker purchase and the dividends on its preferred stock, will be $42,000 per month."

To George Westinghouse, Jr.—one of the most remarkable business men of this generation, combining, as he does, fine inventive and engineering ability with strong practical common sense in financial and commercial matters—is undoubtedly due the credit for bringing about this consolidation at a time when the advantages to be derived from the removal of the Walker Company as a serious competitor in the field could best be realized. Large and valuable contracts for electrically equipping important elevated and surface railway systems are soon to be placed, and it has been well understood for some time that the Walker Company was in a position certainly to dictate the prices at which these contracts will be let, and also to bring important influence to bear toward the actual securing of them. At one stroke Mr. Westinghouse has removed this competition from the field, and at the same time has greatly improved the chances of his own company for securing these contracts. The entrance of ex-Governor Flower, Anthony N. Brady, James W. Hinckley and Perry Belmont into the Westinghouse directorate is an important feature of Mr. Westinghouse's plan, as they will doubtless influence contracts in many directions aside from the large markets in many cities which they completely control.

Major J. W. Hinckley, president of the Walker Company, has had an important influence in shaping the latter's business policy, and has been a tireless worker in its behalf. Though a man of large and varied financial and business interests, this in the electrical field has been in many ways his favorite enterprise, and to its development he has given much of his time, and has secured for the Walker Company not a few important strategic and commercial advantages. Among the orders recently closed by the Walker Company may be mentioned one for 500 Walker motors, placed in Paris a few weeks ago, and an order for 600 Walker motors and 600 Walker controllers, placed by the Brooklyn Rapid Transit Company early in September.

It is understood that the Walker Company will retain its separate commercial existence for the present, at least, and perhaps permanently, and that so far from reducing the force at the Cleveland factory, it may even be increased, as it has been well known for some time that the factory facilities of the Westinghouse Company are inadequate for their constantly increasing business.

Sidney H. Short, vice-president of the Walker Company and the man to whom the credit is due for building up its large line of successful apparatus, is a prominent figure in the electric railway industry of to-day at home and abroad. The history of the Walker Company and a bare statement of the character and amount of original designing and construction work which has been done during the past four years, are interesting and well worth recollection.

The first product of the Walker Company was the Walker spring mounted street railway motor, brought out about four years ago. There were rapidly designed, built and placed upon the market a complete series of this type of motor, ranging in size from 20 h.p. capacity for 31-in. gage track to 200 h.p. for elevated and heavy railroad service. Thousands of these motors have been maufactured and shipped to all quarters of the globe, and it is claimed for them that not one has been returned to the shop for failure to do the work for which it was sold. Forty different sizes of generators, ranging from 25 k.w. to 3000 k.w. (the largest generator in the world, now under construction for the Boston Elevated Railway Company), have also been designed, built and put into service in this brief period. Nearly all of these machines have been of the direct connected type, and built for isolated and central lighting, power and railway stations.

On both generators and motors there has been introduced the new so-called "straight out winding," which is now a feature of modern electrical machinery, and which represents an enormous advance over previous methods of winding. The Walker dynamos and motors are noted for their high efficiency, simplicity of construction, and their sturdy ability to take heavy overloads without destructive sparking at the commutators. Many other detail improvements of great importance have also been introduced in the design and construction of these motors and generators, such as the sliding of the generating field frame lengthwise of the shaft of the machine so as to uncover the armature and fields for inspection, cleaning and repair without disturbing any of the parts of the machine; the making of motor coils entirely of flexible conductors, avoiding soldered joints, the placing of motor bearings entirely outside the motor casing, thereby excluding oil from the interior of the motor; the hinging of the lower half of the motor in such a way as to permit it to swing down without disturbing the armature or the suspension; and the spring suspension of the motor over the axle, as well as at the side furthest from the axle.

Among the later work carried out by the Walker Company is the development of a full line of alternating current apparatus of the "rotary field stationary armature" type, of which about 15,000 h.p. in generators, motors and rotary converters is now under construction; the development of a full line of switchboard apparatus, and the introduction of the solenoid blow-out controller.

It will easily be seen what an immense amount of technical work is represented by these achievements. At the end of the first year after the introduction of the manufacture of electric apparatus into the Walker Company's shops, the gross sales of manufactured product were more than doubled, and at the present time, four years after this introduction, the annual business of the company has increased tenfold. One-half the factory output is shipped to Europe, and the company has come to be recognized all over the world as one of the three largest American concerns engaged in the electrical manufacturing business.

It is needless to say that this enormous development of business has required large additions to the capital invested, and in 1896 a reorganization was made, by which the Walker Company succeeded to the business of the old Walker Manufacturing Company. Cleveland capital was at first sought for and obtained, but eventually Messrs. Flower, Brady and Hinckley, who are, as has been previously mentioned, large purchasers of electric railway apparatus, were invited to become stockholders in the Walker Company, and finally obtained by purchase a controlling interest.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Color Photographs by Electrolysis.—M. L. Delvalez has presented to the Académie des Sciences a method for making photographs in natural colors by the aid of electrorysis. His method is, in brief, as follows: If a plate of brass is put into a bath of a mixture of solutions of lead and copper acetates, through which a uniform current is flowing, the brass plate becomes a "parasite" electrode, current entering it on one side and coming out at the other, and a thin isochromatic sheet of lead peroxide is deposited upon it.

Becquerel has shown that if two plates of silver or copper, placed in an electrolyte, are unequally illuminated, that an e.m.f. is set up between them. Hence if different points of the same sheet of metal are differently illuminated currents will flow in the electrolyte surrounding it. These currents produce electrolysis and a deposit of lead dioxide is thrown down. Points equally illuminated will be equally covered in the same time, and will show the same color (the color being due to the thinness of the film of lead oxide).

On a brass plate under a negative with an exposure of twenty minutes to full sunlight a colored positive was obtained. The blacks of the negative gave the clear yellow of the brass plate, the shades gave various colors according to their density, dark green, fawn yellow, red of several degrees of purity, etc. The plate should be washed in much water and immediately dried. It changes, but slowly. If the positive is viewed through red glass in a proper light the actual colors of nature are said to be apparent in the picture. This may be true, but it seems at least doubtful. The author is seeking a white metal for the plate and a proper electrolyte, and suggests iron and tartar emetic solution.

Telegraphy with Ultra-Violet Light.—Prof. Karl Zickler contributes to "Elektrotechnische Zeitschrift" a long article describing a novel method of wireless telegraphy, which was designed to obviate the difficulty caused by the radiation of the ordinary Hertz-wave signals equally in all directions from the transmitting apparatus. This feature of Hertz-wave signaling makes it of little value for the purposes to which it is best adapted. Prof. Zickler uses ultra-violet light as the medium for his signals. An arc lamp of convenient size is arranged with a parabolic mirror or quartz lens to gather its radiations into a parallel beam. This is received at the receiving station by the apparatus illustrated in the accompanying diagram. A glass vessel having a window of quartz, p, contains the electrodes, e_1 and e_2, one of which is in the form of a plane inclined at 45 degs., and the other is a small ball. The air in this vessel is exhausted to a moderate degree. An induction coil is arranged as shown in the diagram, its secondary e.m.f. being adjusted to a point just insufficient to spark across the gap between the electrodes.

The arc lamp gives off radiations rich in ultra-violet rays. To these glass is practically opaque, while quartz is transparent. These rays have the power to promote electric discharges. Hence if the light of the lamp is allowed to enter the receiving apparatus sparks will pass and the signals may be received as electrical radiations by a coherer or read off by means of a telephone in the secondary circuit of the coil. A plate of glass mounted in front of the arc lamp is used as a shutter to cut off the ultra-violet radiations and produce the signals. This apparatus can be easily adapted to the ordinary searchlight. The glass shutter makes no apparent change in the visible light, so that the messages sent along the beam are secret. With an arc of 25 amperes Prof. Zickler thinks that signals may be sent to a distance of several miles.

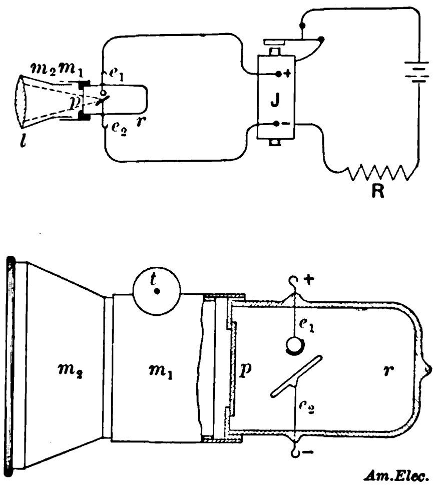


DIAGRAM OF ZICKLER RECEIVER AND CONNECTIONS.

It seems possible that this method is capable of much refinement. If an appropriate screen is provided, which will allow the ultra-violet rays to pass and block off the luminous rays, the message and the location of the stations as well would be secret and the apparatus well adapted to military telegraphy. The receiver is far less complicated and delicate than the coherer apparatus, while the induction coil required is so small as to be easily portable and reliable in its action.

Electrical Resistance and Temper of Steel.—M. H. Le Chatelier has presented to the Académie des Sciences a series of valuable observations on the effect of temper and constitution upon the electrical conductivity of steel. The most important experiments were directed to ascertain the influence of the temperature of tempering upon the conductivity, samples of steel containing 0.84 and 1.13 per cent of carbon being chosen. The subjoined table shows the ratio of the resistance after tempering to that before tempering, the temperatures being given in the top line:

Temperatures: (Centigrade)...	710°	740°	810°	850°	950°	1000°
0.84% carbon..	1	1.3	2.1	2.2	..	2.2
1.13% carbon..	1	1.3	1.6	2.1	3	..

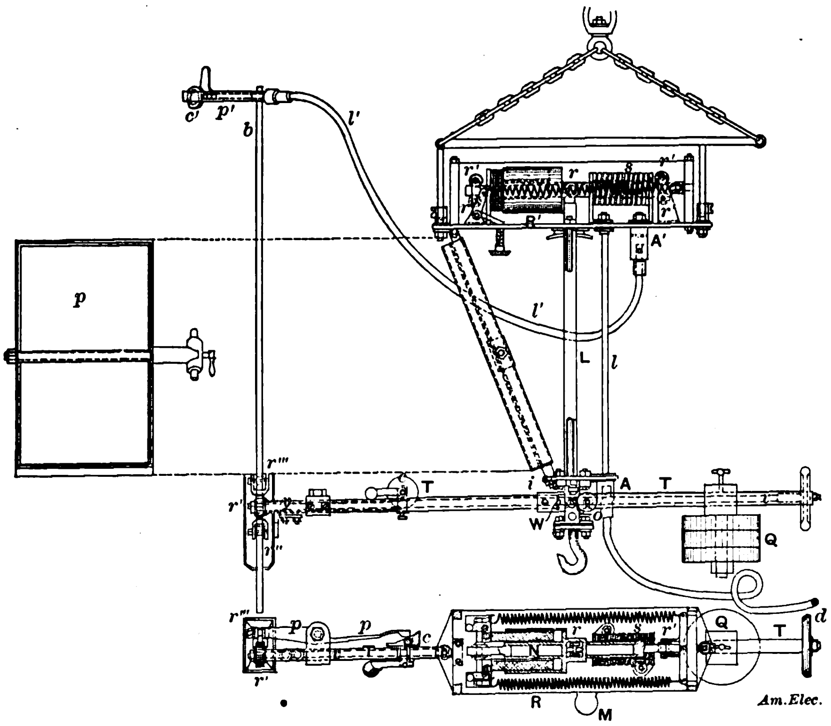
These results go to show that tempering does not modify the resistance if performed at temperatures below the point of recalescence (710 degs. C.), the same condition holding good for the change in mechanical properties. The resistance then increases with the temperature of tempering up to a maximum depending upon the carbon content of the steel, the higher carbon steels going up to higher resistances. The presence of chromium in the steel causes the increase of resistance to become more marked, while tungsten seems to exert a contrary influence.

Electric Soldering and Welding.—M. Simon Hetter presented to a recent meeting of the Association des Ingénieurs Electriciens, of the Montfiore Institute at Liege, Belgium, a most interesting paper on the various electric soldering and welding processes in use in Russia. These comprise a number of methods not generally known in this country and contain many valuable and practical suggestions.

The Bernados process uses the arc established between the metal to be built up or repaired and a carbon rod held in the hand of the workman. To repair a blow-hole, for instance, the surface of the work is first heated with the arc, then a number of bits of metal are placed upon it and dusted with sand or some other material to act as a flux. The arc is then struck between these pieces and the carbon and when they are melted the current is turned off and they are forged into place before they harden. The proper current strength is determined by experience. If the arc makes no sound it is not strong enough. If it hisses sharply the current is too strong. The proper current is indicated by a slight humming of the arc. To prevent too much contamination of the metal by carbon the arc should be as long as possible. Care should be taken not to heat the metal too much, as few metals can stand the arc temperature long without destruction. After the patch is in place it should be reheated for some time by a charcoal fire, otherwise the unequal contraction of the neighboring parts may produce a rupture. In working on cast iron the arc is shortened when the metal is melted (the added metal being the purest obtainable iron) so that it will absorb as much carbon as possible and make an easily worked cast iron when cool.

In the Slavianoff process a metallic rod is used in place of the carbon electrode of the Bernados process. This rod may be of the same metal as the piece worked upon or of any other metal, according to the necessities of the case. By choosing a metal that melts at a comparatively low temperature the melting of the electrode reduces the temperature of the arc, so that there is less danger of burning the work.

The electrode is generally suspended on a feeding mechanism over the work, and is fed to it mechanically. If a blow-hole or a crack is to be repaired it should be enlarged so that the arc can reach every part of its interior. A mould can be built up around the work of coke or carbon blocks and sand, if this is necessary, as it may be if the pieces to be repaired are broken entirely apart. The author gives illustrations of the method of forming new teeth on a large gear wheel by the use of carbon moulds of appropriate shape. In general this method consists of the melting down of the material of the electrode and of pieces of metal placed in the mould. The illustration shows the arrangement of the feeding mechanism for the metallic rod. The whole is suspended from a crane, Q being a counterbalance weight and P a frame of colored glass to protect the eyes of the workmen. The metallic electrode is shown at b b. In the upper part of the apparatus is a regulator for feeding in the rod as it melts away. To start the arc the rod b is placed in contact with the work and the current turned on, when the arc is automatically struck and the rod fed down as it melts. Direct current is used, the polarity being such as to suit the work and depending upon whether it is desired to melt the rod rapidly or heat the work. The current strength depends upon the size of the surface worked upon, being generally about 8 amperes per square millimeter or 5000 amperes per square in. at a minimum pressure of 50 volts. The rod melts quite rapidly, a cast iron rod melting at the rate of 1 lb. in one and one-half minutes under a current of 400 amperes.



SLAVIANOFF ELECTRIC WELDING AND SOLDERING APPARATUS.

The remainder of this important article is comprised of practical directions for operation and formulæ. It is, unfortunately, too long to bear condensation into the space available here.

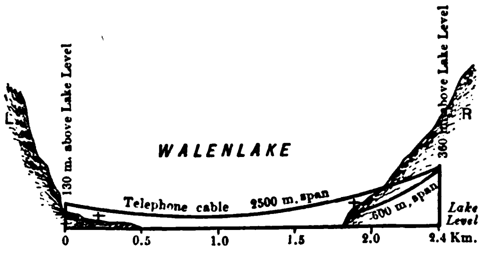
The Resistance of the Human Body—A paper has been presented to the Académie des Sciences by M. Dubois concerning the variable period of current flow when a difference of potential is applied to the human body. His method was to measure the charge gathered in a condenser connected in circuit with the resistance to be studied and a battery, contact being made for a very short interval by a steel rod rebounding from a steel anvil. He concludes that the reactance of the body, during the period before the current reaches the state of definite and steady flow, is less than its resistance; in fact, the capacity of the body seems to partly neutralize its ohmic resistance. During the period of variable flow the resistance of the body remains constant, its value depending on the surface of the electrodes in contact and the length of the part of the body between them. M. Dubois thinks that the body acts as a condenser with a liquid dielectric and places its capacity at about 0.165 microfarad.

Contact Resistance of Similar Metals.—M. Edouard Branly describes in "Comptes Rendus" (abstracted in the "Electrician") some experiments on the contact resistance of similar metals. A column resembling a Volta's pile was made by threading forty-five discs about 1½ ins. in diameter and ¼ in. thick on an ebonite rod and putting the whole under slight pressure. In the case of iron, aluminum and bismuth the resistance was low if the discs were placed gently on one another, but if they were dropped on one another with a slight shock the resistance was enormously increased. With discs of zinc, copper or brass the resistance was practically zero however the column was assembled. The following figures show some of the data of these phenomena. With a pile of aluminum discs gently laid together and subjected to a pressure of about 5 lbs., the resistance was 1.5 ohm. By dropping the discs on one another and submitting the column to the same pressure the resistance was increased to 40 ohms, diminishing to 21 ohms after twenty-four hours. On taking the column apart and rebuilding it gently without cleaning the discs, the resistance was 2.2 ohms, and when again remade by dropping the discs together it was 215 ohms. Connecting the column between the spark terminals of a radiator reduced the resistance to 0.5 ohm. The same effect was noticed with iron and bismuth. M. Branly makes no attempt to explain these curious phenomena.

Aluminum Electrodes—Mr. E. Wilson gives, in the Proceedings of the Royal Society, an account of his experimental work upon the behavior of aluminum electrodes in a saturated solution of alum. Aluminum and carbon electrodes were used and an exploring electrode, consisting of a bit of platinum wire sealed in the end of a glass tube, was inserted midway between the plates. The current was adjusted to 3.5 amperes, using the aluminum as the cathode. On reversing the e.m.f. the current also reversed for a few seconds, but soon fell to zero. The effective e.m.f. opposed by the aluminum amounted to about 22 volts. To determine the nature of the resistance of the surface of the aluminum the plate and its film of oxide were immersed in clean mercury, the results going to show that while the film is a fairly high insulator it is not stable. At times the resistance fell to zero, when a sharp crackling noise, like sparking in air, would be heard in the cell, the resistance at once mounting up to as much as 10,000 ohms. Even under a pressure of 30 volts the film was able to restore its insulating properties at ordinary temperatures, but at 70 degs.C. about 3 volts was the limit. A film formed by wetting the aluminum in a solution of alum and then exposing it to the air gave the same results as the film formed in the electrolytic cell. Experiments with alternating currents showed that the best rectification effects are obtained if large currents at low e.m.fs. are used. The full effect is not developed if the frequency is higher than about sixteen cycles per second.

Working Aluminum.—The following hints for the working of aluminum are taken from the "Practical Engineer." It is best melted in a sand crucible, without any flux, at a temperature very little above its melting point (a dull red heat). In casting allowance should be made for the great shrinkage in cooling, and large risers and plenty of vents should be provided. The molds should be cooled from the bottom upward to allow the gases to escape. Aluminum can be forged hot or cold, but best at a temperature that causes a hard wood stick to smoke when pressed against the metal. In turning the cut should be very light, the speed high, and both tool and work plentifully lubricated with kerosene. In filing use a single cut file, as the metal soon clogs a cross-cut file. Frosting, which must be done before the surface will take paint or enamel, is accomplished by dipping the metal in a solution containing 10 per cent of caustic soda and 2½ per cent of common salt. When the work turns black take it out, brush in water, and immerse in strong nitric acid until the surface becomes white again, then wash and dry in sawdust. For polishing use a mixture of olive oil and rum followed by rouge and turpentine. To engrave the surface should be coated with oil and rum, otherwise the tool slips continually.

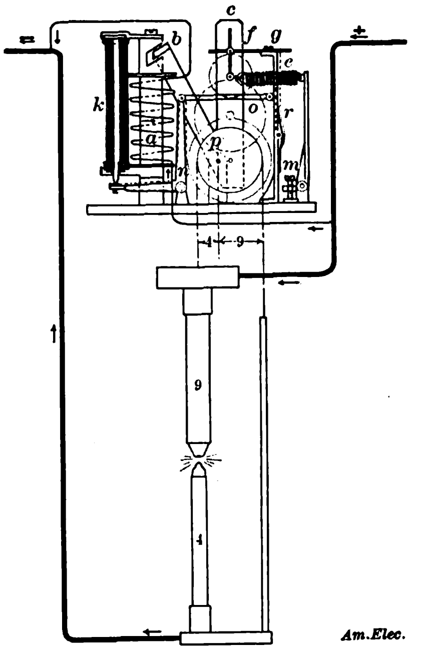
A Long Span.—The longest span of wire in Europe, says "Engineering," crosses the Walenlake in Switzerland. The span crosses the lake between the villages of Quinten and Murg, its length being 2500 meters or 1.56 mile. On the Quinten side the point of suspension is on a rocky spur 1180 ft. above the level of the lake, another single span 0.375 mile long being led back to the station in the town. On the Murg side the point of suspension is 426 ft. above the lake level. Between the two points the cable hangs in a curve having a dip of 590 ft., its lowest point being about 160 ft. above the water level. The first wires used on this span, both single steel wires, broke either from winds or ice forming on them, and they were replaced by a cable of three galvanized steel wires, each about No. 8 gage. This cable has also recently broken, the wind causing a sort of whipping action or wave motion in it, which is attributed in part to the unequal heights of the two end supports. It is proposed to reerect it with terminal stations of equal height.



TELEPHONE CABLE ACROSS THE WALENLAKE.

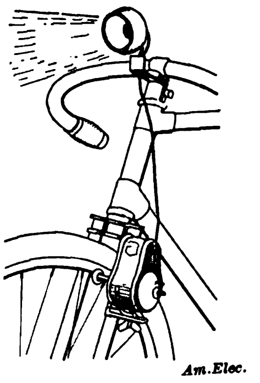
Artificial Rubber.—A new process for the manufacture of artificial india-rubber comes from Germany, says the "Mechanical World." It consists in the oxidation of linseed oil with the addition of prepared jute refuse or other similar hitherto worthless textile fibre, a substance being produced having many of the qualities of genuine rubber. It is capable of being utilized in many ways and of being manufactured into various articles hitherto made of rubber. It is not stated what oxidizing agent is used, but it seems that this would be a good opportunity for the use of ozone. Whether or not the new substance can be vulcanized is not stated, but it seems possible that it may lend itself to this process. There is certainly no reason to suppose that the synthesis of rubber is impossible, now that the chemical journals have just announced the synthesis of albumen.

Heat Compensator for Arc Lamps.—In shunt arc lamps the heating of the coil increases its resistance and hence causes the lamp to maintain a longer arc unless some device is used for the correction of feed mechanism. An English lamp, described in the (London) "Electrical Review," uses an ingenious compensator. The system of tubes, in the accompanying figure, is composed alternately of iron and brass, so connected as to add their expansion under increased temperature. As the lamp mechanism warms up in use these tubes expand and by a simple lever mechanism adjust the position of the striking tongue of the feed release train, as plainly shown in the figure. A great advantage of a regulator of this type is the saving of energy due to its use, as the increased resistance of the arc caused by the heating of shunt coils simply causes waste without any compensating gain. Of course in compound wound lamps the tendency to lengthen the arc as the mechanism heats is less noticeable.



HEAT COMPENSATOR FOR SHUNT ARC LAMP.

The Dynamo Bicycle Lamp.—The (London) "Electrical Review" prints the accompanying illustration of a dynamo bicycle lamp, the dynamo being driven from the front wheel of the bicycle. It is a little strange that this device still holds a place in the journals. Assuming such a mechanism added to a bicycle, the energy required to keep the lamp going would soon wear out the hardiest rider, while the light would promptly go down whenever he slowed his speed. To be of the least use a bicycle lamp should be of from 2 or 3 c.p. Taking 2 c.p. and allowing 10 watts for the current consumption, and supposing the dynamo or magneto to have the high efficiency of 50 per cent—high for so small a machine—the rider would be required to furnish 20 watts of power, or, allowing for friction and losses, 25 watts. This is almost exactly the power required to propel a 150-lb. man on a 20-lb. bicycle at the rate of 9 miles per hour on a level. Riding at that speed the turning on of his light would mean to the rider doubling his effort. It is safe, therefore, to predict that the dynamo bicycle lamp will continue to be popular only in illustrations.



A DYNAMO BICYCLE LAMP.

The Bow Trolley.—An article by Herr Stobrawa in "Elektrotechnische Zeitschrift" (reprinted in "L'Electricien") discusses the advantages of the Siemens & Halske bow trolley as compared with the usual wheel variety. The bow trolley, which is without a single example in this country, consists (see Fig. 2) of a light metal frame, the upper part of which is bowed upward, the whole being pressed up against the trolley wire in the usual way. The contact is not a rolling one, but a sliding contact, the upper part of the bow sliding along always at right angles to the trolley wire. This form of trolley has many advantages to commend it. While at first sight less mechanical in its arrangement than the familiar wheel, it shows excellent results in comparison, and it is unfortunate that it has not had a test under American conditions.

By making the bow of relatively softer metal the wear upon the trolley wire is rendered nil, the whole wear being confined to the bow, which is replaced when worn out. The first serious disadvantage encountered was the noise due to the sliding of the bow on the wire, but this has been ameliorated by the use of bows having a cross section shown in Fig. 1. The frame of the bow is aluminum, the hollow parts being filled with stiff grease. In Basle (Switzerland) the life of such a bow was found to be about 13,000 car miles, and the replacement cost about 0.017 cent per mile run. The greasing of the trolley wire not only gets rid of the noise, but assists in its preservation and prevents the formation of ice on it in winter. The great and prominent advantage of the bow trolley is, however, that it stays in contact with the wire.

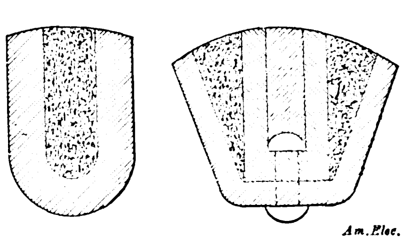


FIG. 1.—CROSS SECTION OF BOW TROLLEY.

Referring to Fig. 2, which shows an end view of a car thus equipped, it is seen that by making the framework of the bow of flexible and elastic tubing the bow, even if the alignment of the overhead conductor is so bad as to throw it into the position shown by the dotted line, will by its own friction work back under the wire. No cords are used with these trolleys. When the car is reversed the bow catches under the wire by its own friction and is thrown over to the proper running position. It is stated that the wear on the trolley wire at Dresden, where these trolleys are used, has diminished its section only 4 per cent in four years. The diameter of the trolley wire is not stated.

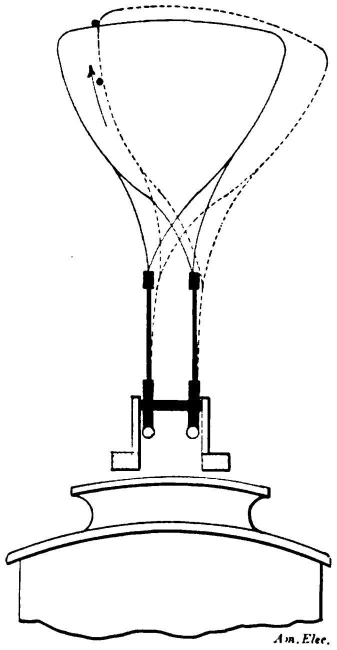
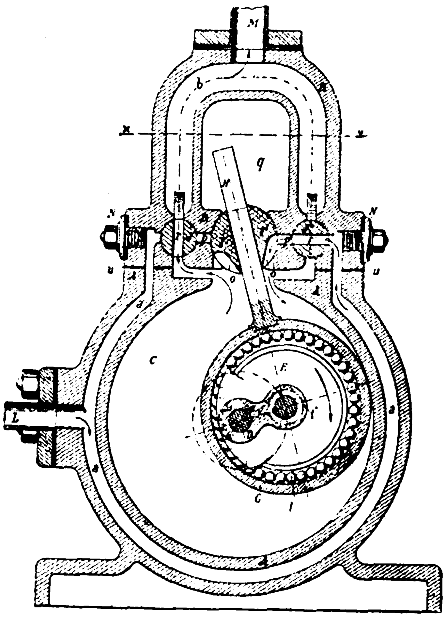


FIG. 2.—FRONT VIEW OF BOW TROLLEY.

Regenerating Fluorescent Screens.—At the recent meeting of the Association Française pour l'Avancement des Sciences M. P. Villard presented a communication upon the regenerative action of light on fluorescent screens of platinocyanide of barium. It is well known that when these screens are exposed for a long time to the action of X-rays the salt darkens in color and the fluorescence of the screen diminishes. According to M. Villard an exposure of the screen to direct sunlight for fifteen or twenty minutes completely restores its properties. The infra-red rays in sunlight seem to be the most active in the work of regeneration. A practical suggestion is that such screens should be kept exposed to daylight, their properties being thus indefinitely preserved.

Electrolytic Damage to Ships.—The "Electrician" abstracts from the "Engineer" an account of a curious lawsuit brought by the captain of the port of Leghorn (Italy) against the owners of certain wooden yachts. It appears that these yachts, which were copper sheathed, were moored with steel cables to a buoy in the harbor to which some new warships and other steel vessels were also made fast. Under these circumstances electrical action ensued, the bottoms of the vessels being the plates of a gigantic battery, and the fact of damage to the steel vessels from the ensuing electrolysis was clearly proved. The court directed that the port captain's order for the removal of the coppered yachts to another part of the harbor be sustained.

A New Rotary Steam Engine.—An exceedingly ingenious and interesting rotary engine is described at some length by M. Emile Demenge in the "Revue Générale des Sciences." The illustration here given showing a cross-section through the shaft is almost self-explanatory. An eccentric cam, E, is surrounded by a ring piston resting on two runs of balls, as shown. Attached to this piston is a steel partition plate, H, which slides through and oscillates the valve, II. Steam is admitted at L, and, after encircling the working cylinder, is admitted through the valve, II, to one side of the piston and the partition plate. The exhaust goes out through the valve, J, which is constantly open. By turning this valve and its counterpart on the other side of the machine through 90°, the direction of rotation is reversed. Nothing is said as to the efficiency of this engine, but a machine of this type 12 ins. x 14 ins. x 24 ins. in size and weighing 308 lbs. is said to have shown an output of 6 h.p. at 300 r.p.m. with steam at 145 lbs. It might be developed into a valuable type of engine for direct-connected dynamo driving on a small scale, though the steam turbine will probably soon have this field all to itself.



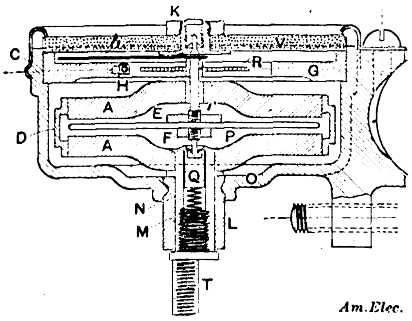
ROTARY STEAM ENGINE.

Station Lights.—The (London) "Electrical Engineer" makes the sensible suggestion that the lights in an electricity supply station should be wired from an independent source whenever practicable. In this way an accident resulting from the shutting down of the station would not leave it in darkness. In the Shoreditch station the lights are connected to the storage battery independently of the main switchboard, but this method of connection is only useful where there is an accumulator. In case of the bursting of a steam pipe, for instance, the plant would be left in darkness under ordinary conditions at the very time when light is most urgently needed. This detail is one of great importance, as many stations are entirely dependent upon their own operation for light. Would it not be a good idea to pipe city stations for gas and introduce fixtures for emergency use? The suggestion seems a step backward, but it is nevertheless a practical one.

Influence of Electricity Upon Clouded Liquids.—Herr Spring, in "Chemische Zeitung," gives some interesting and important observations upon the action of electricity in clearing muddy fluids. Pure water, in which is suspended particles of non-electrolytic material in fine subdivision, becomes clear when a current of electricity passes through it or when a salt or an acid is added to it, or when it is warmed. The current may be very small if the e.m.f. is sufficiently high. Herr Spring explains this phenomenon by the assumption that the suspended particles, in a non-conducting fluid, are in an electrical condition, perhaps a condition intermediate between the neutral state and that of ions, and that this prevents their aggregation and sedimentation. When a current flows, or if the fluid is made a better conductor through the addition of an electrolyte, or if convection currents are set up in it by heat, the particles are discharged and are free to aggregate in masses and sink. According to the author this peculiar electrical condition of suspension is possibly due to the overcoming of the original adhesion of the substance reduced to the finely divided condition of suspension.

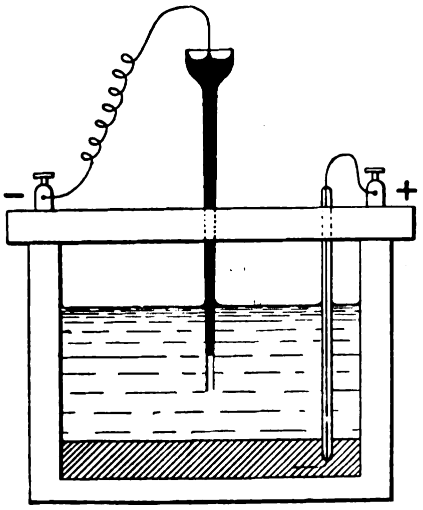
This phenomenon is certainly worthy of the most careful study on account of its important practical bearing. If the sedimentation of muddy waters can be brought about by electrical action it may be possible to substitute some variety of electrical treatment for filtering plants in many places, notably along our inland rivers, where clay in suspension, rather than any bacterial impurity, is removed from town water supplies by filtering.

A Magnetic Speed Indicator.—A new form of speed indicator, adapted to use wherever it is desirable to read off the instantaneous revolution speed of a shaft, is described in "La Revue Technique." The permanent magnets, A A, are rotated by the shaft T, which is attached either directly or through gearing to the shaft whose speed is to be measured. F F is an aluminum disc turning on a pivot resting on a jewel, Q, in the head of the shaft, T. The motion of this disc is restrained by a spring. On the pivot is a needle, a, playing over a graduated scale. When the magnets are turned the rotating field of force between them tends, by virtue of the formation of eddy currents in the aluminum disc, to cause it to rotate in the same direction. This tendency being opposed by the spring causes the disc and its needle to take a position of equilibrium depending on the speed of the magnets and of the shaft T. The principle of the apparatus is an exceedingly ingenious application of well known laws, and seems worth development into other forms of apparatus.



MAGNETIC SPEED INDICATOR.

Simple Capillary Electrometer.—The "Electrician" contains an abstract of an article by Sig. G. Vanni in "Nuovo Cimento," on a form of capillary electrometer adapted for school use and for lantern projection. The figure is almost self-explanatory. The glass-sided cell contains a layer of mercury on the bottom covered by a 30 per cent mixture of sulphuric acid and water. A capillary tube with a funnel top is inserted through the cover into the acid and water and mercury poured into it. This descends to a position determined by hydrostatic pressure, the bottom of the column forming a good contact with the acidulated water. Potential differences of less than 0.001 volt may be readily shown with this instrument.



A SIMPLE CAPILLARY ELECTROMETER.

ELECTRICAL MISCONCEPTIONS.

The student of electricity frequently encounters odd misconceptions, and these are persistently the same with different individuals. For instance, the term "line loss" has puzzled many an electrician. He cannot at first conceive of a loss in the line unless there is an actual loss of electricity. He is told that amperes means the volume of electricity flowing in the wire, and he consequently expects that at the end of the transmission line he will find less amperes delivered than at the engine room. Add to this the actual fact that such a phenomenon obtains in telephony and telegraphy, and unless he is carefully instructed, he is very likely to remain for a long time under the impression that the line loss, as commonly expressed, means a loss of amperes, and not of volts. His ideas on the subject are apt to lead him into very amusing errors. For instance, we hear of a salesman, who writes home asking his company how much it would cost to wire a building for 5 per cent loss, and also, how much it will cost to wire it for no loss.

The sinusoidal curve, commonly employed to illustrate alternate-current phenomena, is frequently a great source of worry to the student. In his search for something tangible he imagines the electricity taking a similar tortuous path in the wire. He may, perhaps, study the subject a little deeper and realize that the current is merely of rapidly varying strength, and perhaps has this illustrated to him by the mechanical analogy of water oscillating back and forth in a tube. Unless he is carefully instructed at this point he will shortly be under the misconception that the ordinates of the alternate-current curve represent linear distances on the wire, and that the current is at various densities at various parts of the wire, accurately spaced off according to the sine law. The superposition of two or three current curves, together with curves of impressed and induced e.m.f. upon the same platen, gives him an idea of multiplicity of currents and pressures within the wire, all of which does not tend to reassure him that he is mastering the subject.

An armature-winding diagram is another source of trouble to the student. The closed circuit type is particularly distressing. He starts to trace out the current, and proceeds from commutator bar to commutator bar around the armature, and arrives at the place whence he started, forgetting that the circuit is from brush to brush.

He then gets the idea that the revolution of a closed circuit armature generates a current which doubles around and around on itself through the winding, and that this current is tapped off to the commutator at points of greatest potential difference.

Another source of trouble to the student is the arc dynamo. Here is a machine in which the more resistance you put across the terminals the higher the potential becomes. It is a series dynamo. He has been taught that to insert resistance reduces the current; according to that, the current in the series fields should be reduced, and hence the e.m.f., which is proportional to the field strength, is also reduced.

If he studies the dynamo further, he gets into still more interesting tangles. He has been taught that the torque of an armature, which is the measure of the h.p., is proportional to the strength of the field and to the current in the armature wires in the arc dynamo. The current is constant, and therefore constant in the field magnets, which are in series with the main circuit. The armature current is also constant, and hence he draws this surprising conclusion, that, as the strength of the field and the armature current are always the same whatever the load, the torque of the dynamo is always the same, and, if the speed is constant the h.p. is always the same, no matter what the load may be.

Perhaps his attention is now called to the regulator and the function that it performs, and he may for a time charge the regulator with the explanation of a great many of his troubles, until he finds that manufacturers produce arc dynamos some of which are almost, and others quite, inherently self-regulating. Then he is back where he was before.

Again, we find our student puzzled in the study of the transformer. He learns that the primary and secondary current are 180 degs. apart, practically opposed in phase. He learns that the secondary current neutralizes the magnetic effect of the primary, and when the transformer is fully loaded, the primary acts almost as a non-inductive resistance. In line with this reasoning, he finds that in transformer design the two currents are inversely as the transformation ratio, and that the ampere turns of each are identical. He then argues if the ampere turns of the primary are opposed to those of the secondary at all times during full load and equal thereto, they neutralize each other and there is no flux of force in the transformer core at all. Why should the transformer be complicated with such a construction? There have been cases where the student has solved the difficulty by the conclusion that the core was only needed to start the action, and after the load is on the core is unnecessary.

He studies electric motors and learns that the weaker the field of a motor the faster it will run. This bothers him for a moment, but the various arguments are advanced, and possibly a dash of practice or two are thrown in, and he is convinced that it is the fact. He then studies the principle of the Thomson recording wattmeter, which is a motor with its armature on constant potential, the speed varying in proportion to the load that it measures, and to his confusion he finds that the stronger the field current the faster the motor goes.

If he attacks the subject of electric heaters, he very quickly deduces the fact that electricity is transformed into heat conveniently and economically by allowing it to flow through a resistance, to strangle it down, as it were, and force it to give out its heat. The more resistance, the greater should be the heat, so says his formula, $C^2 R$, and such has been his understanding all along. He is, therefore, most wonderfully surprised, and inclined to doubt the sanity of the instructor he has always looked up to, when he finds that in order to get more heat out of a constant potential circuit the resistance of the heating device is reduced.

It is puzzles like these that make the study of electricity hard. The young electrician asks for information on a few of these points, and finds that his misconceptions are so ludicrous that he gets roundly laughed at. To avoid ridicule, he forbears to ask again, and unless he dissolves his difficulties by strength of intellect, they remain a continuous puzzle and protest against the accuracy of the science.

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Dangerous Voltages.

If the reports of recent electrocutions are to be believed, it is possible to make a sufficiently good contact with a man's body so that 2000 volts will pass through it at a current of 10 amperes, and therefore the resistance of the body is in such a case about 200 ohms. Almost every electrician has at one time or another measured the resistance of his body, either by clasping two handles firmly or by pressing his fingers on the tops of binding posts, and varying results have been reached, some as high as 40,000 ohms. Indeed, the fact that the resistance of the body varies so widely is well known to electrical engineers, and even to those who are merely interested in the science. In view of this there does not seem to be any reason for the wonder which is sometimes expressed, when a man receives a shock from terminals, the pressure between which is in the thousands of volts, and survives. The conditions of contact determine the matter entirely.

It must be evident to anyone that it is the amount of current that is forced through a man's body that kills him, and if his resistance can be satisfactorily reduced, 500 volts will be as fatal as 5000. As a matter of fact, however, accidental shocks are generally made through very poor contacts. The current usually has to pass through the most highly resistive part of the body, the callous of the hands, and, moreover, the contraction of the muscles, which instantly follows the reception of a powerful shock, frequently disconnects the victim from the wires altogether, although in some unfortunate cases it has been known to tighten his grip upon them, according to the position his hands may have been in at that time. These conditions account for the reason that sometimes death is incurred through a 500-volt shock, while another person accidentally subjects his body to a potential of 2000 volts and recovers.

The voltage is a very unsafe criterion on which to base the fatality of a shock. The volume of the current is what kills, and is a much more accurate measure of the fatality. Unfortunately for accuracy, however, what the current was in the case of a shock is seldom if ever known. The voltage is almost always known, at least approximately, and consequently it has been used as the basis of comparison; but when it is realized that in order to obtain an estimate of the ordeal through which the victim has passed, this voltage must be divided by a resistance varying from 200 to 50,000 ohms, it is easy to see that the conditions might have been almost anything.

The Use of Electro-Magnets for Mechanical Control at a Distance.

In passing through a switchyard, where a large railway traffic is transacted, the electrical engineer is at once imprssed with the multiplicity of rods, bell crank levers, interlocking bolts and complicated mechanism between the rails, and the mass of wires, chains and pulleys which operate them. This mechanism has to be boxed in, wherever possible, requires continuous oiling and attention, is more difficult of operation the longer the distance it is required to span, is easily obstructed and liable to be hopelessly wrecked if a car should be derailed upon it. This has been appreciated by engineers, and in many places pneumatic systems have been installed, whereby pipes take the place of chains and wires, and cylinders and pistons at the point where the work is to be done supply the necessary pushing and pulling forces.

Pipes leak; cylinders and pistons are accurate mechanical devices and require cleaning and attention; and the system requires a source of pneumatic power to operate it. It seems strange that electricity has not been used for this service. A well-designed ironclad solenoid, taking only about 100 watts, can exert a pull of 100 lbs. through a distance of several inches, and can be conveniently supplied from a 110-volt lighting circuit. There is no question but that the necessary pulling power to manipulate the switches and signals can be electrically supplied in apparatus more compact and convenient than any other. But this is not the only advantage that electrical switching apparatus presents. The connecting and controlling wires may be laid in lead covered cables in ducts under the trackway or in the ground. Distance does not enter into the consideration; the magnets will operate as well at the distance of a mile as at a distance of 20 ft., and a mile radius far exceeds the range of any interlocking switch system. The cost of a lead-covered cable buried in the earth is very likely to be less than that of a wire supported at intervals on pulleys and boxed in, and will not require one-tenth the attention of the mechanical devices. With the electrical system the track can be cleared of all moving parts, an advantage which cannot be overestimated. The destruction attendant upon the derailing of an engine has been mentioned, but, aside from that, mechanical devices require to be kept clear from obsruction. A piece of coal falling from an engine tender can easily block a switch, and in winter time the track has to be kept clear of snow throughout all the intricate construction of the levers and rods. It can be seen at once that to obviate the necessity of this care is no mean advantage, and it certainly pertains to electrical methods.

In addition to all that has been mentioned, we have an immense advantage in interlocking. The very simplest devices will render it impossible to supply a magnet with current until another has been manipulated and a tell-tale lamp system can be inaugurated which will give the operator at all times exact information concerning the condition of the track. With the present mechanical systems a miniature track may be operated by the same levers which operate the actual switch, but it is easily possible for the miniature to operate and the switch itself be blocked. With the electrical system, the tell-tales can be arranged to positively show whether the switch is open or closed.

The control station becomes at once very much smaller. A flagman's house will answer where a large structure was required before.

In these days of electric lighting it is possible to obtain sources of current to manipulate such a system which shall be practically unfailing. At central depots the electric light plant at the station can be called upon, also the mains of the local electric lighting company, and perhaps wires from a third isolated plant in the neighborhood can be brought into play. The amount of current required is so little that the duty impressed on any of these installations is negligible. A small storage battery might be added, and in this way it would be easy to obtain at least two supplies of power, either of which would be very unlikely to break down. The certainty of operation would thereby be brought to a point far in excess of either the pneumatic or mechanical system. There is a field for business here which is very nearly a virgin one. New interlocking switch stations are continually being installed throughout the country. The pneumatic system is displacing the mechanical one, and it remains for an electro-magnetic system to displace them both.

The Regulation of Dynamos.

When the rheostat on a shunt dynamo is adjusted to effect a change of voltage the operator cannot fail to note that the response is very sluggish, so much so indeed that it is very easy to manipulate the rheostat handle so rapidly that the voltmeter cannot follow it. Although most designers are certainly aware of this, it is surprising to note that at stated periods a device appears which has for its object the regulation of voltage and for its principle of voltage-controlled device which in turn controls the field rheostat. If the action of a field magnet is so sluggish that it will not quickly follow changes in rheostat resistance made by hand, how can it be expected to follow the infinitely more rapid variations which sudden changes of load will create in a sensitive automatic device? In making an automatic regulator to keep the voltage steady under sudden changes of load the variation of the field strength must not enter as a factor. There have been cases where regulators have been produced, using two field magnets in the linkage of regulating factors between change of voltage and readjustment thereof. This was done by the device of separately exciting the exciter field and controlling the current in that circuit. The idea of this seems to be that the controlling device would be smaller, its parts would have less inertia and it would therefore be more sensitive. The designer seemed to be totally oblivious to the fact that however sensitive the regulator was made, the interposition of a field magnet in the regulating system destroyed its utility and the insertion of two such sluggish members, the one dependent on the other, is practically fatal. Extreme accuracy of potential regulation is not obtainable in this way, and unfortunately there is little else of a practical nature that can be offered in its stead. Absolute regulation, while always desirable, can be dispensed with in commercial work. An expedient which may answer in some cases is to vary the speed, to which function the voltage almost instantly responds, as every gas engine manufacturer can testify. Of the many ways of doing this the method of shifting a belt on two conical drums by a magnetically controlled shifter may be suggested. In such a case the generating armature must be of small flywheel capacity. There is, however, a more practical application which may be used on engine-driven dynamos, namely, that of controlling the speed of the engine electrically. The cut off of the engine can be varied by potential magnets instead of centrifugal or inertia governors. This device is by no means a new one. It has been tried in numbers of instances and always with marked success. The difficulty which seems to have stood in the way of its commercial exploitation is the fact that engines and dynamos are separately manufactured, and the steam engineer has no faith in anything but a centrifugal or inertia governor. If some maker was to incorporate enough electrical engineering talent into his draughting department and produce an engine that would regulate for constant current or constant potential, as required or ordered, he would certainly create a stir among plant designers who have had troubles of their own, especially in the case of alternate current machinery.

Electrical Heaters.

The theoretical efficiency of an electrical heating device is 100 per cent, but it is well known that this does not in any way affect the fact that electric heating is the most expensive of all methods of supplying calorific energy. The only excuse for the existence of electric heaters is the great convenience in application which they afford, and to date the fullest advantage has not been taken of this feature. For instance it is a simple matter to improve the efficiency of heaters for liquids by placing the heat emitting resistance within the liquid to be heated, thereby absorbing all of the heat generated, and economy of heat in such devices is much to be desired when the source of heat is so expensive. It would seem that alternate currents can easily be adapted so as to control the entire field of electric cooking and similar applications of electric heating, because of the facility with which the voltage can be transformed. By reducing the voltage and correspondingly increasing the current volume it is possible to heat a plate of metal to any degree desired, and that plate may be the bottom of a cooking utensil. One of the chief difficulties of electric heaters, especially those intended to give very intense temperatures, such as soldering irons and the like, is the insulation of the heated conductor. With low voltage currents the conductors are few in number and the insulation required is very slight, and the task becomes an easy one, and very frequently the heated conductor can itself be the actual working surface of application without involving the wasteful process of radiation or conduction.

Electrical heaters designed to take the place of stoves are practical only on the electric street car, where current is generated in large quantities and the cost to the company is merely that of production. It is certain that existing types of car heaters can be improved upon and their location better chosen. It is proverbial that heat applied to the feet of a chilled person will be more effective than anywhere else. It therefore follows that the position for railway heaters is directly in front of the seat and flush with the floor line. Beside this economy of position the heater coils can be separated, so that part of them form the motor regulating resistance, which in cases of crowded traffic frequently becomes hot enough to boil water and even red hot. In summer time a double throw switch will serve to switch in the ordinary resistance under the car and cut out the heater. The actual saving by this device is by no means inconsiderable.

SIMPLE VOLT-, AMPERE-, AND WATTMETERS.

BY CHARLES T. CHILD.

Many experimentalists and workers in practical electricity are embarrassed by the high cost of commercial forms of ampere-, watt- and voltmeters, and are unable to provide themselves with these almost indispensable instruments. It is the purpose of this article to describe several forms of such instruments that can be easily made by the amateur or student with the tools generally found in a small shop and at small cost.

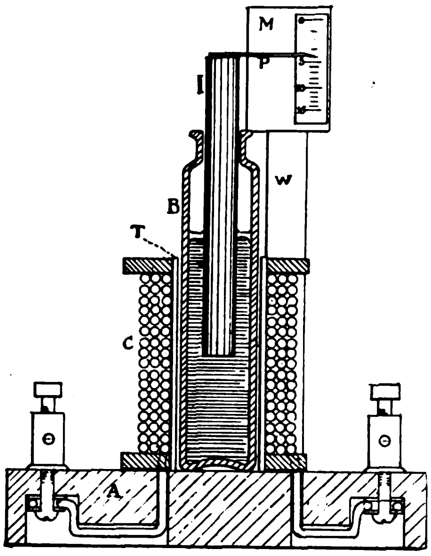


FIG. 1.—SOLENOID AMMETER.

The fundamental principles underlying the construction of such meters are extremely simple. Almost any arrangement of parts that is subject to alteration by the passage of an electric current can be made to serve as a meter, provided it is properly calibrated; that is, if it is known exactly what changes a definite current causes. For example, a simple compass, with a current-carrying wire stretched parallel to the needle in its normal north and south position, will serve the purpose of an ammeter if it is first determined what deflection will be caused by each of several given currents in the wire. By varying the current and noting the position of the needle a scale may be made reading directly in amperes, and the instrument thus becomes a rough form of current meter. An ordinary high-resistance galvanometer may be used, in the same way, as a voltmeter, but these instruments, from their crudity and sensitiveness to disturbing conditions are not reliable or convenient, and in practical work have been superseded by instruments specially designed for the measurement of current or electrical pressure. The difference between a voltmeter and an ammeter is simply a matter of the way the instrument is connected to the current-carrying system that it measures. An ammeter is an instrument of low resistance, through which passes the whole of the current to be measured; a voltmeter is in all respects similar, except that it is of high resistance and is connected in multiple with the circuit, or across the points whose difference of potential it is designed to measure. Under these circumstances a small current, small on account of the high resistance it encounters, flows through the instrument, and as this current is proportional to the potential difference which causes it the instrument measuring the current gives an indication of the pressure at its terminals. It is evident that the higher the resistance of the voltmeter the less the current withdrawn from the system by it and the less the disturbance of the potential conditions due to its use.

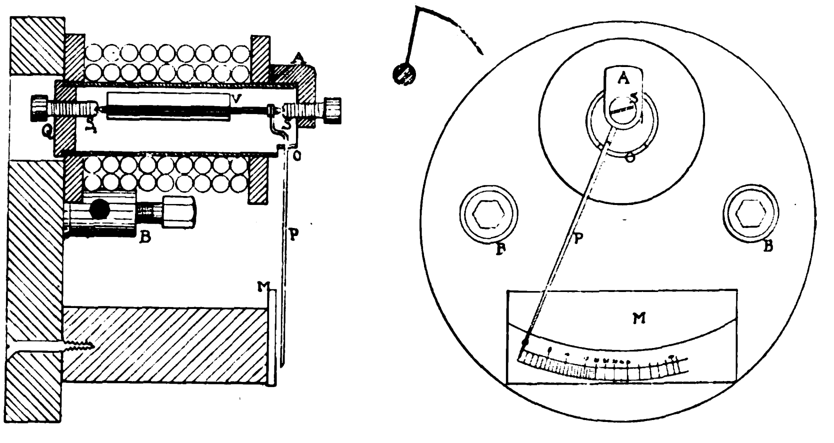
Nearly all forms of meters depend upon the magnetic effects of the current for their action. These may be divided into solenoid instruments, magnetic vane or needle instruments, and moving coil instruments. Another class of instruments of great importance uses the heating effect of the current, which produces expansion in a strip of metal or a wire, as the source of their indications.

One of the simplest forms of ammeters is shown in Fig. 1. This instrument is intended to stand on a table or bench, and is of the semi-portable variety; that is, it may be moved about if care is taken not to spill its liquid contents. It consists of a bar of soft iron, I, floating in mercury contained in a glass bottle, B, and surrounded by a coil, C. The bottle is of the sort known as a "sample phial" and much used for exhibiting samples of oil, etc. It should have a neck about ⅜ in. inside diameter, and the body of the bottle should not be more than twice the diameter of the neck. The iron bar, I, should be turned down until it fits loosely in the neck of the bottle. The coil is about two-thirds the height of the bottle and contains a number of turns and a size of wire proportional to the currents to be measured by the instrument. For currents up to about 15 amperes No. 10 wire and about fifty turns are recommended. The mercury should be poured into the bottle until the bottom of the iron rod floats at about half the height of the coil, and on the top of the mercury should be poured a few drops of kerosene to prevent oxidation of the mercury surface and the formation of a film which would impede the motions of the rod. When current passes the rod is drawn down into the solenoid against the buoyant action of the mercury.

Soldered to the top of the iron rod is a pointer, P, moving in front of a scale. This scale is drawn on paper and pasted to a piece of looking-glass, M, which is supported by a wooden standard, W. No iron should be used in the construction of this ammeter except the rod, I. The purpose of the looking-glass is to avoid errors of "parallax," or those caused by reading the position of the pointer from an angle. By placing the eye so that the pointer just covers its image in the mirror the observer is certain of being in the proper position for correct reading.

To make the scale the position of the pointer with no current passing in the instrument is noted. The instrument is then connected in series with another ammeter and a current sent through both of them. By varying this current and noting the positions of the pointer for definite indications of the standard instrument the scale is dotted down, and can be afterward carefully ruled in permanent shape. The care that is taken with this operation, the calibration of the instrument, will determine its future value. At best, however, this instrument is only a rough makeshift, though it will be found very satisfactory when only rough measurements are desired. It is not suitable for alternating currents and should not be used with them.

By replacing the coarse wire coil shown with a coil of very fine wire of high resistance the instrument becomes a voltmeter, but it is not recommended to use this type of instrument for that purpose.



FIGS. 2 AND 3.—SECTION AND ELEVATION, MAGNETIC VANE AMMETER.

A more satisfactory instrument is shown in Figs. 2 and 3. Here the fact that the lines of magnetic force crowd close together along the inner sides of a solenoid is used as the principle of action. The coil of large wire is wound on a brass tube with wooden or fiber heads, one end of the tube being closed with a brass plug, Q. A piece of brass, A, is soldered to the other end of the tube, and through this and the plug are screws, S and S_1, coned out for the reception of the pointed ends of the pivot, as shown. The screws must be of brass or other non-magnetic material. They are not arranged in the center of the tube, but are a little above it, say 5-32 in., if the tube is an inch in diameter. On the pivot, which is of hard steel, is mounted a little vane or wing of thin sheet iron (the sort used by photographers for the basis of "tin-types" is best) bent to the shape shown in the small detail drawing. This should have about the relative size shown in the illustration. The needle, P, is of aluminum wire, for the sake of lightness, and the whole is so balanced, by soldering on bits of copper wire if necessary, that it hangs normally as shown in Fig. 3. The vane being eccentric to the tube carrying the coil tends to approach its inner surface when current passes. It must be so attached to the pivot that this tendency causes the needle to sweep over the scale, M. As in the instrument just described this scale is of paper mounted on a scrap of looking-glass. The whole is attached to a circular wooden base and forms a convenient wall or switchboard instrument. A cover to exclude dust and keep off stray air-currents would be a valuable addition.

This ammeter may be made very sensitive and accurate if care is taken in its construction. The lighter the needle the more sensitive the instrument, other things being equal. To decrease its sensitiveness the lower part of the needle system should be loaded so as to bring the center of gravity of the whole lower and thus cause a greater tendency for the needle to return to its zero position. Like the first instrument described this may be converted into a voltmeter by the use of a fine wire high-resistance coils of many turns in place of the coarse coil shown. For such an instrument, used as an ammeter, and measuring currents up to 100 amperes, about eighteen or twenty turns of wire ¼-in. in diameter will be found sufficient.

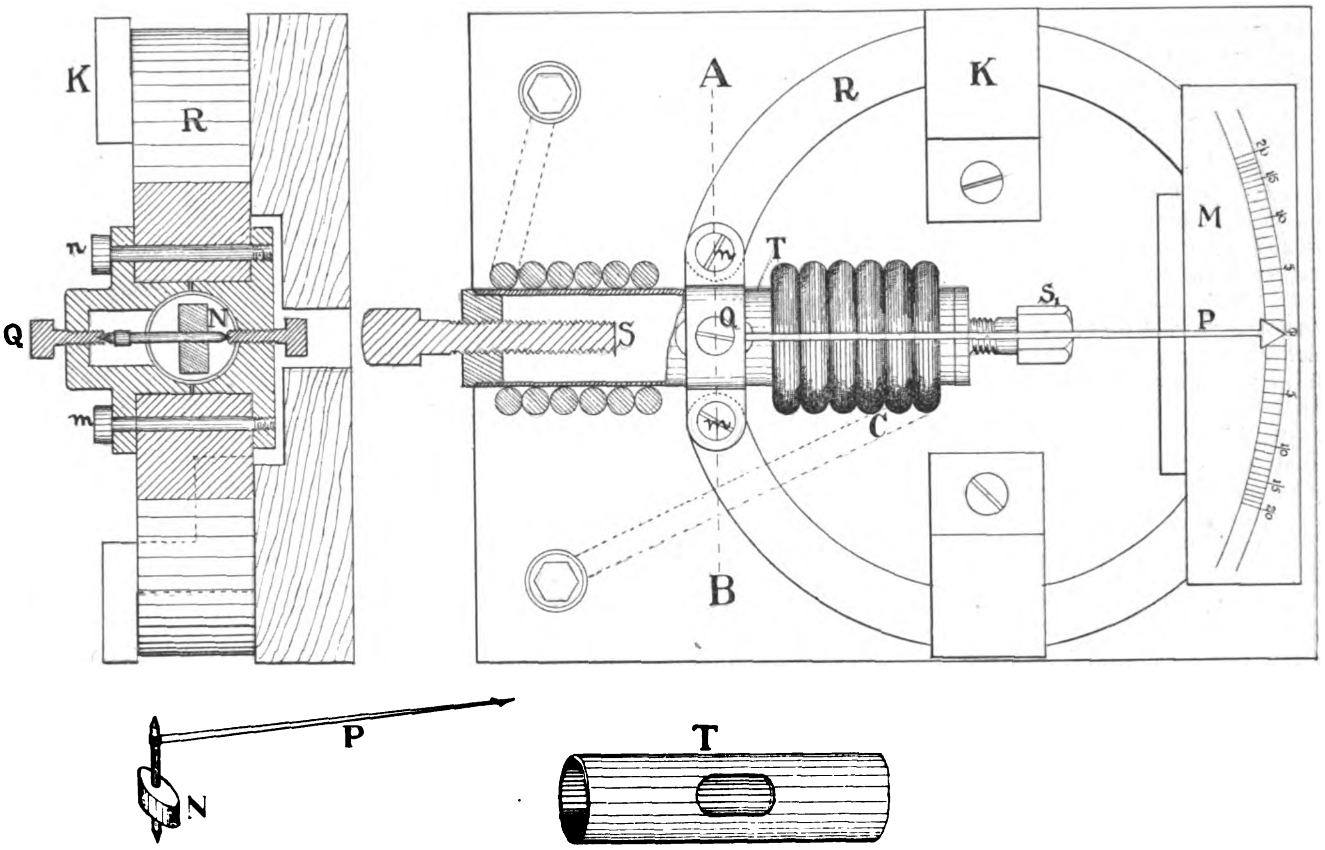
There are many cases where it is desirable to know the direction of the current as well as its volume. Neither of the instruments described indicate this. The next ammeter to be described not only indicates the direction and amount of the current, but also possesses two valuable qualities not shared by the cruder forms described—portability and freedom from vibration of the needle. In other words, it is a "dead-beat" instrument, the needle going promptly to its place on the scale and stopping without vibration. It is a very satisfactory and useful instrument and will be described at some length on account of its various good qualities.

The ring, R (Figs. 4 and 5), is made of good quality tool steel, 1 in. x ½ in., and bent around a diameter of 4½ ins. The ends do not meet, but are rounded off as shown by dotted lines in Fig. 5, leaving an opening about 1 in. between them. After this ring has been forged into shape and finished by the rounding of the two ends and the boring of the two holes for the screws, m and n, it is hardened by heating it red hot and suddenly cooling it in water, or better, a solution of sal ammoniac. It is then magnetized by wrapping it with about fifty or one hundred turns of wire and passing a strong current, or by rubbing it on the poles of a dynamo, and after magnetization it is boiled for an hour in water. Then it should be magnetized again, and again boiled, this being repeated several times, the magnetizing always being done in the same way and never reversed. By this method of magnetizing and boiling the ring is brought to a permanent state and does not lose its magnetism, as would be the case if no such precaution was taken.

The tube, T, shown also in one of the small detail drawings, is of brass, 1 in. outside diameter and about 1-16 in. thick and 4¼ ins. long. In the middle of it is cut an opening ½ in. wide by ¾ in. long, as shown in the small drawing. This is for the withdrawal of the iron needle described below. Referring to Fig. 4, which shows a cross section of the instrument on the line A B (Fig. 5), it is seen that the tube is supported between small castings of brass which are clamped between the poles of the permanent ring magnet by the screws m and n. To the lower of these castings the tube is soldered at its middle, the opening already described being on the upper side, as shown at Q, Fig. 5. The upper casting clamps the tube solidly in place when the two screws, m and n, are drawn up tight.

Through these two castings are tapped brass screws coned out for the reception of the pivot carrying the needle, N. This pivot is of hard steel wire, the ends being coned in a small lathe or ground off to shape on an emery wheel. On it is mounted the soft iron needle, N, shown in perspective in one of the small drawings. This should be of the softest and purest iron obtainable, ⅝ in. long over all, about ⅛ in. wide in the middle, and about the same thickness, measured along the pivot. It must be filed carefully into perfectly symmetrical shape. Attached to the pivot is the aluminum pointer, P, which sweeps over a scale and mirror as described above. It will be noticed that the zero point of this scale is at the middle, the needle being deflected in either direction, according to the direction of the current.

In the ends of the brass tube, T, are soldered two plugs carrying the soft iron screws, S and S_1. These are intended for the regulation of the scale of the instrument, and once adjusted are to be left alone. By screwing them in nearer the



FIGS. 4 AND 5.—PERMANENT MAGNET PORTABLE AMMETER.

needle, N, the instrument becomes more sensitive, that is, it gives a larger deflection for the same current. Hence, when the instrument is assembled, the maximum current it is intended to register should be sent through it and screws adjusted until the needle is at its extreme deflection.

To soften the iron screws, S and S_1, put them in a small sand crucible and cover them with powdered lime. Then heat the crucible to a cherry red heat in a charcoal or anthracite fire, leaving it to cool very slowly as the fire dies down. The lime prevents the formation of a scale of oxide on the screws, which may be cleaned after they are cool by dipping them for a moment in weak muriatic acid and washing in water containing a little ammonia.

The coil is wound as shown on the brass tube, its ends being attached to appropriate binding posts. The figure shows a coil of only twelve turns, intended for the measurement of fairly large currents, but for small currents the wire may be smaller and the turns more in proportion. For currents up to 15 amperes use No. 10 wire and put on sixty turns, thirty on each end of the tube.

The ring magnet, R, is fastened down to the wooden base by clamps, K. As shown in the illustration the instrument is a table form, adapted for use in a horizontal position only. If the needle system shown in the small drawing is balanced perfectly for all positions (which would require a small counterweight to compensate for the pointer, P_1), the instrument may be used in any position.

For use as a voltmeter the coarse coils shown should be replaced by coils of fine wire wound on insulating spools and slipped over the ends of the spool. Indeed, a combination instrument may be made by slipping these spools on over the ammeter winding as shown. For the best results these spools should contain the largest possible amount of the finest possible wire, and should be connected, in addition, through a resistance in the base of the instrument, care being taken to so wind the latter that it does not produce any magnetic effects. The total resistance of the coil and the additional resistance for measurements up to 150 volts should not be less than 9000 or 10,000 ohms. For higher voltages additional resistance or a shunt must be used. Unless the resistance is very high so much current will flow through the coils that they will heat or even burn out if the instrument is left in circuit, hence the necessity for care in providing enough resistance. It is also to be noted that a voltmeter is exposed to the full pressure of the current that it is measuring, and that its insulation cannot be too careful. In an ammeter the fall of potential is utterly negligible and insulation is not a feature of particular importance, but with a voltmeter this is different, a short circuit leading instantly to disastrous results.

The above instrument, which is similar to those made by Carpentier and Ayrton & Perry, is a thoroughly satisfactory shop meter, if carefully and accurately made. Unfortunately, like the other instruments described above, it is useless for alternating currents.

(*To be continued.*)

HOW TO MAKE A DRY CELL.

Dry batteries, so called, are only dry in the sense that there is no fluid spilled or slopped over when they are shaken or overturned. In every voltaic cell the current is derived from the chemical action which goes on within its substance, and no chemical action can take place between solids alone, but in all cases there must be present a liquid or a gas. Some few cells employ gaseous electrolytes, and some, fused salts, but the vast majority use aqueous solutions of their respective chemicals, and it is in this class that the ordinary dry cells are to be found. Even the old dry piles of Zamboni and others, which consisted of discs of paper coated with metals (gold and silver paper) laid up "dry," in reality contained a very small amount of moisture in the paper, and if the paper is really perfectly dry, the piles will not work. If the ordinary dry cell then requires moisture to make it work, and is in fact only a non-spilling wet cell, it is a natural inference that the wetter the cell, consistent with it not spilling or slopping over, the better. This inference is absolutely correct. The more fluid a dry cell contains the better, for many wet cells would be improved for having a larger amount of electrolyte than they do have.

It might seem in view of what has been said, that any wet cell, if well sealed up, would do for a dry cell, but such is not the case, for several reasons. Many cells will not stand sealing up tight, because they give off gases, and these must have free vent, and again it is not always practicable to seal up a cell so that it will not leak at all when inverted. Again, it is not worth while to seal up a cell, except one of the kind that will last for considerable time before it gives out or even needs replenishing. Another desideratum of a dry cell is that it should not be easily broken, as there are many places where cells are liable to fracture as well as upsetting, etc. For these reasons, it is customary to dispense with the glass jar, and to make the zinc serve the double purpose of containing jar and electrode, and further, to use an absorbent substance that will take up and hold the fluid electrolyte like a sponge, so that the seal is rather to prevent evaporation and creeping of salts, than spilling or slopping. The types of cells giving the best results on open circuit work, as wet cells, naturally do the best when put up in the dry form; consequently, as might be expected, the vast majority of dry cells on the market are some form or variety of the sal-ammoniac type. Several of the manufacturers of dry cells claim to have valuable secrets relating to their manufacture, but however true this may be in regard to the details, the main requirements are well understood.

In making a dry cell, the first thing requiring attention is the jar. This, as before remarked, is usually made of zinc. The cell is usually cylindrical, although sometimes square or oblong in section, but in any case a piece of moderately heavy sheet zinc is bent into the required form, the edges soldered together and a bottom soldered in. Any one who tries to solder zinc for the first time may be very much surprised and disgusted to find that it does not take kindly to soldering like tin plate, but balks and makes lots of trouble. However, by observing the proper precautions, zinc may be soldered with comparative facility. Thoroughly clean all the parts where it is intended that the solder should stick, by scraping; use clean chloride of zinc for a flux, and apply the solder as near the point where it is needed as possible, not trying to make it flow over the surface of the zinc as can be so readily done with tin plate, for the more the solder alloys with the zinc, the more intractable it becomes. Learn to make a joint quickly on the first application of the soldering bit, as the more you fuss and tinker with it the rougher, more unsightly and more uncertain it becomes. Another pleasant little habit of zinc is to strip the tinning off the soldering bit. You may have tinned your bit with the utmost care, but after using it a short time find it completely stripped. Some persons prefer an iron bit to the usual copper one, claiming that it holds the tinning better, although somewhat more difficult to tin in the first place.

Having made the jar, the next thing to attend to is the contents. One of the most important constituents of the contents is the absorbent. Several materials have been used for this purpose, among which are plaster of paris, gelatinous silica, gelatine, so called, which is really the starchy mass obtained from boiling Irish moss; gelatinous magnesium oxychloride and a material made from the granular portion of the rind of the cocoanut, called cofferdam. There are other materials, but these are the more important ones. As the process of filling the cell differs somewhat for each kind of filling, it is better to describe each one separately. The zinc usually has a brass binding post soldered to its rim on one side (there being no objection to this structure in a dry cell, because the electrolyte cannot possibly come in contact with the junction), and the other electrode, which is usually of carbon, has a binding post of the same kind, fastened in one of several different ways.

The seal is made of pitch or some similar material, which will form an air and water tight stopper, and also resist the tendency of the salts to creep, as does the paraffin coating on the upper part of the jar of an ordinary sal-ammoniac cell. It is simply melted, poured in on top of the charge and allowed to cool in most dry cells, but some manufacturers make a sort of safety valve or pressure regulator, by inserting a small piece of rattan so that it passes completely through the seal, its ends projecting slightly above and below the pitch. The natural porosity of the rattan is sufficient to relieve any pressure generated by the escape of gases, but it will not of course provide for the swelling of the more solid portion of the contents which sometimes takes place when the cell is subjected to too high a temperature, and cells are frequently destroyed by bursting when placed in boiler rooms and other situations where the temperature rises to an inordinate degree.

One of the important qualities of a dry cell is long life on open circuit, which means that the local action should be negligible, and it is in the prevention of local action that some manufacturers claim to have valuable secrets. Bi-sulphate of mercury is sometimes used to keep the zinc amalgamated, as in wet cells. This, of course, does some good, but it is not all. Anything that will tend to keep the chemical composition of the electrolyte uniform in all parts of the cell will help to prevent local action.

We will now consider some of the particular forms of dry cells. The Cox cell is formed by boiling Irish moss in sal-ammoniac solution until it is thoroughly gelatinized, and pouring it into the zinc jar, where the carbon electrode has been already placed. Bin-oxide of manganese in conjunction with the carbon as a depolarizer is, of course, used as in the wet form. The inventor also mixes a little bi-sulphate of mercury with the electrolyte. Some of the other sal-ammoniac cells as described do not use it, but there is no reason why they should not, and the reader should understand that he may use it or not in the other cells described. When the moss solution is cold it sets to a firm jelly, and is then ready to be sealed. Obach's cell is made by mixing plaster of paris with the sal-ammoniac solution and pouring it into the jar to harden. Mehner's cell is made by mixing the sal-ammoniac solution with chloride of calcium and calcined magnesia, forming a paste of about the consistency of cream, which is poured into the jar, and in two or three days forms a stiff jelly, owing to the formation of oxy-chloride of magnesium. In Gassner's cell the following composition is used: Oxide of zinc, 1 part; sal-ammoniac, 1 part; plaster of paris, 3 parts; chloride of zinc, 1 part, and water, 2 parts, all by weight. The oxide of zinc is intended to make the plaster more porous, giving this cell an advantage over the simple plaster cell before described.

Gelatinous silica is precipitated when any strong acid is added to a solution of silicate of soda, and several inventors have used silicate of soda to gelatinize the electrolyte in storage cells. This, of course, introduces sulphate of soda into the electrolyte, but this does no harm, and is even regarded as beneficial by some. The charge and discharge rate of the cell is much reduced, and it will not do to allow much gas to be generated in the jelly, neither can the cell be sealed up perfectly tight, but a vent must be left for the escape of gas. The spattering or spraying during charge, however, is cured, even if no cover is used.

Gelatinous silica may be used in any electrolyte in which the sodium salt, formed at the same time with the silica, is not detrimental. It is very difficult to wash the silica, and it does not pay to do it for such a purpose as this, so if it is intended to use the silica with sal-ammoniac it is better to precipitate it with hydrochloric acid, instead of sulphuric, as in that case the precipitated silica will contain chloride of sodium, instead of sulphate.

The Germain cell, which at one time attracted considerable attention, used the material known as cofferdam, previously mentioned in this article. The containing vessel of this cell is made of wood boiled in paraffin, the carbon plate is imbedded in lumps of peroxide of manganese and carbon, and the rest of the space is filled with cofferdam saturated with sal-ammoniac, the zinc, which is well amalgamated, is laid on top, and the cover (or rather the side) is screwed on, slightly compressing the contents.

It will be observed that some of the directions for the manufacture of dry cells are very particular about the amalgamation of the zinc, even when the electrolyte is sal-ammoniac, but, as a matter of fact, most of the dry cells on the market are made with unamalgamated zincs, which is a pretty good proof that the amalgamation is superfluous. There have been many other dry cells proposed, some quite elaborate in composition and others less so, but the different forms of the sal-ammoniac cell are at the present time used to the exclusion of everything else.

One practical difference between wet and dry cells is the different manner of using them. In the wet cell, we endeavor to use some of the parts, such as the containing jar, indefinitely, and the porous jar, if there is one, at least a very long time. We also endeavor to use up the zinc as completely as possible, expecting to renew the electrolyte several times before the zinc is all gone. With dry cells, however, it is the common practice to throw them away as soon as they fail from any cause to do their work. The zinc being also the containing jar, it manifestly cannot be all used up, but on the other hand must be discarded as soon as it is perforated, if indeed something else does not give out before this event, as is intended.

Dry cells are intended more particularly for a class of consumers who do not care to be bothered with the manipulation of wet cells. When they come from the factory they are ready for use without any preparation whatever, and when they are exhausted they may be thrown away without compunction, for they are made for such a low price that it does not pay to spend much time or trouble on them, even when they happen to be in such a condition that they may be restored, which is not usually the case.

The zinc electrode-jar must be insulated in some way, especially when several of the cells are used in series, as in this case any external conductor touching two of the cells would short circuit at least one of them. For this reason they are usually varnished, and often in addition placed in strawboard boxes.

Judging from the variations in the different cells on the market, and which work satisfactorily, it would appear that the exact proportions of the ingredients are not very important. In the nature of things the electrolyte is the first thing to give out, and there is no danger of getting too much of it, and the solution should be saturated. The carbon and manganese should not take up too much space, and as in the wet sal-ammoniac cells the manganese is usually thrown away before it is exhausted, from the fact that the inner part of each lump is unavailable, it is evident that a small amount of manganese will answer the purpose, if arranged so as to be available, for which purpose it is better to have it rather finely broken, than in large lumps, and in as intimate contact as possible with the carbon. There being no danger in a dry cell that the manganese will become displaced after having been once fixed, there is no objection to its being in a state of powder.

CUTTING BY STEAM.

BY JAMES F. HOBART, M. E.

The engineer has for a long time been aware that metallic surfaces suffer when exposed under certain conditions to the impingement of steam currents of considerable velocity. It is commonly stated that such action is caused by the "cutting action of steam." In studying this phenomena, it appears at first sight as if there really was a cutting action to or possessed by a jet of steam.

A closer study of the matter demonstrates that steam itself possesses no cutting force or erosive action, at least no more than that possessed by a jet of air at equal pressure. It cannot be said that pure air can ever cut a hole in a piece of iron or brass, no matter how long exposed, or how favorable the action. But charge the air with sand and the erosive effect will immediately appear.

Under the foregoing conditions the harmless air jet becomes a destructive sand blast, and cuts away the hardest steel with ease and rapidity. In like manner pure steam is, or has, all the characteristics of a perfect gas, and will blow through or against a piece of metal indefinitely as long as steam only is thus forced upon the surfaces.

However, an air jet will sometimes cut, and we know that steam frequently plays havoc with valves and other surfaces with which it comes in contact. Then, the cutting is not done by the steam itself, but by the substances it carries along with it. There may always be dust in the air blast, and water in the steam, and it is to the sand blast action of the dust and water that most of the destructive cutting is due in air and steam machinery.

To put the matter in another shape, I may state that in years of experience with steam machinery, in designing, constructing and operating, I have never yet seen a case of cutting by steam alone. All the cutting found in valves and in boiler shells and rivets, is done by something other than steam—in most cases altogether by water. The proof of the statement develops by an examination of any case of cutting which comes to light. A careful examination will show that the small particles of water carried along by steam under pressure have in all cases caused the destruction of the metals against which they have been blown by the steam.

An example of this may be found in Fig. 1, which is part of a pump generator valve used for keeping a Worthington fire pump in service condition. The cutting action is shown at a and also at b. Upon taking the valve out it was found that the cutting had taken place only at the bottom side of the valve, where water of condensation passed through it. The upper portion of the valve was free from any cutting action.

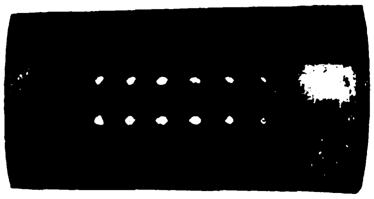
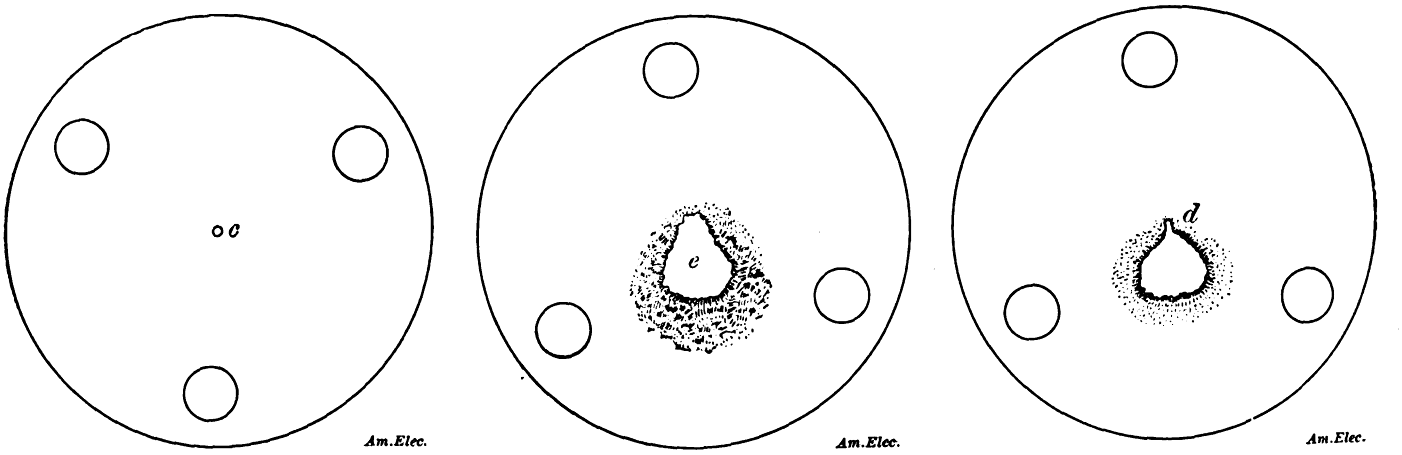


FIG. 1.—CUT PUMP VALVE.

The valve is conical, and has a rotary oscillating motion when in operation. When nearly closed a very small portion of the opposing holes on the steam passage overlap, and these holes have been elongated on one side, as shown. The only traces of cutting at the top of the valve are in slight elongation of a few of the holes, and this was doubtless due to water in the steam pipe, which at times must necessarily flush the entire valve, as there is a good deal of water in pump pipes at times, when the pumps are run as slowly as possible.

One of the worst cases of valve cutting I have ever seen is represented by Fig. 2. These illustrations were made from a 1-in. valve taken from a steam plant in the West Indies. I cannot give the length of time the valve was in service, or the treatment it met with, therefore the testimony of the engravings must be all that will be known of this matter. The valve had the appearance of being new, and bore only the wrench marks made at the time the stem was removed from the body of the valve. No other wrench marks whatever were to be found upon that part of the valve in my possession.



FIGS. 3, 4 AND 5.—DIFFERENT SPECIMENS OF CUTTING IN A STEAM DIAPHRAGM.

From the appearance of this valve, the disc had been screwed down upon some foreign substance, probably a little dirt, and left there until steam had driven water enough through to spoil the valve. Then, even if the valve had been closed, the rest of the cutting is easily accounted for, and is only a matter of time. No repairs were made, and the cutting continued until the condition shown by the engravings had been reached.

The removable packing was soon cut through, then the brass was cut away until the collar on the stem was exposed to sight, as shown in Fig. 2.

This valve shows that in order to cut by steam it is only necessary that water be present in or with the steam, and that a certain direction be given to the jet. Then a steady continuation of the jet for a long time, and the conditions are complete.

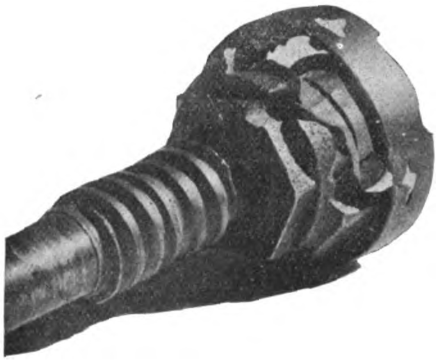


FIG. 2.—CUTTING ON GLOBE VALVE.

An example of cutting which occurred under my personal observation is a good illustration of the fact that water of condensation, and not steam, is to blame. The disc, Fig. 3, was made of plain sheet-iron a little over 1-32 in. thick, and had a 1-16-in. hole, c, drilled through it in the center. The disc was then bolted into an ordinary flange union in a ¾-in. steam pipe and served to reduce the amount of steam supplied to a heating coil for melting paraffine wax. After four or five weeks' use the disc would have to be renewed, and invariably would be found to be cut into the shape of a miniature horse collar, as illustrated by Fig. 4. The enlargement of the hole, d, was invariably at the bottom of the original opening, showing plainly that it was water, rather than steam, that had done the cutting. One diaphragm bore the peculiar cut shown by Fig. 6, where the original hole was left almost intact, and the cut opening entirely below and only connected by a narrow passageway, as shown at d.

In contradiction to the "water" theory of steam cutting, an engineer brought up the matter illustrated by Fig. 6, where a leak at the top of a boiler had resulted in cutting a groove alongside a rivet at a, under the head thereof, and into the head, b, of the adjacent rivet, as shown by the cross-sectional sketch mentioned.

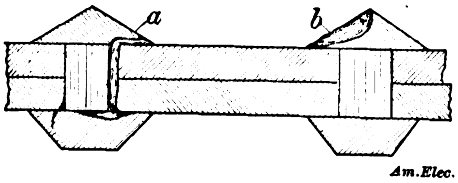
Here was apparently a case where pure steam had done considerable cutting, but upon a close study of the matter it only adds more proof to the "water" theory. It will be seen that the section of opening beside the leaky rivet is very small, as also is the escape of steam under the rivet horizontally. The adjacent rivet has suffered badly, probably ten times as much metal having been cut away therefrom as from the rivet where the leak actually occurred.

In this case, it is evident that the escaping steam has had very little water in it, for the channel is a very small one, and although the leak had existed for several months it had increased very slowly. This, in agreement with the water cutting theory, was because only at the time of getting up and letting down steam in the boiler would there be "watery vapor" blown through the leak, instead of gaseous steam.

On the other hand, the rivet at a distance was constantly being bombarded by particles of water condensed from steam the instant its pressure was released by emerging from the orifice under the first rivet. In addition to this, there is always present more or less dust from the furnace fire, and some of the particles thereof doubtless had a sand-blast action upon the second rivet. The combination of the two causes was enough to perceptibly wear away the second rivet, while the first showed no appreciable signs of increased cutting.

Blow-off and drip valves are more frequently found to be cut than are steam valves, and throttle valves, where the steam pipes are long, are frequently badly damaged. Safety valves are also cut when there is considerable condensation to be driven through them. I have found that safety valves closely connected to the boiler, so they would at all times be hot, were much less inclined to became leaky than were valves connected at a distance from the boiler, so that their temperature could change considerably between the periods of work and idleness.

The ordinary water line glass also exhibits another example of water cutting and freedom from damage by leaking steam. The slightest leak at the bottom end of the glass will result in the glass being cut or reduced in diameter around its entire circumference. Although this cannot properly be called a case of cutting, it shows that water, not steam, does the mischief, for while the water end of the glass tube will be reduced to almost paper thinness, the upper, or steam end will remain untouched and of its original thickness.



Am.Elec.

FIG. 6.—CUTTING AT LEAK IN RIVET.

The well known "snaky" tracks across the seats of valves are made by water being driven over the metal by high pressure, and the crooked paths so often made by cutting particles are caused in the attempt of the abrading particles to follow the line of least resistance.

Cases can be cited where a change in the material of which the surfaces were constructed has completely stopped the cutting action. In the case of the pump valve mentioned above the iron valve was replaced by bronze, with the effect of reducing the number of strokes of the pump per minute from twenty-five to four, and after a year of wear no perceptible increase in speed has been noted.

Another case was that of a throttle valve, in which there was originally a packing which could be renewed at will in the ordinary manner. This packing would cut out in a week so badly that it was impossible to stop the engine without shutting off steam at the boiler. The packing was replaced by a solid bronze disc, and no further trouble has been encountered.

BOILER SCALE AND FUEL CONSUMPTION.

It is stated on good authority that in general 2 per cent of fuel is wasted for every 1-64 of an inch of scale on the heating surfaces of the boiler, and that ratio increases as larger thicknesses are deposited. If engineers would bear well in mind that such minute deposits cause such perceptible wastes of fuel many of them would succeed in accomplishing the coal economy they are striving after. Not a few firemen, if asked why boiler scale was an objection, would reply that the plates which it covered were liable to be overheated and would consider that if they freed the boiler from scale sufficiently often to prevent this catastrophe that they were doing all that was necessary.

INTERIOR WIRING.

BY CHARLES E. KNOX.

FEEDERS AND MAINS.

The feeders and mains constitute the "trunk lines" of the distributing system through which the current is fed to the "branch circuits."

In these articles, where the term feeder is employed, it is intended to refer to a conductor which begins at the switchboard and terminates at a center of distribution; this center of distribution may serve to supply either mains alone (in which case it would be a main center of distribution) or branch circuits, or it might supply both. Any prolongation of a feeder other than a branch circuit is called a main. Formerly the nomenclature included feeders, sub-feeders, mains, sub-mains, etc., but confusion resulted from the use of so many terms, and they have gradually dropped from use and the trunk lines are generally classed as either feeders or mains, their definition being usually as given above.

Before proceeding to adopt any system or method of feeding, it is well to consider in each case certain questions which would influence the feeding system. As these questions present important problems we will now proceed to note them, and then consider them in detail:

1. Control of groups of light (other than hall or night lights) from the main switchboard.
2. Control of hall lights from main switchboard.
3. Maximum number of lights that should be supplied by one feeder.
4. The best maximum limit for the size of the feeder conductors.
5. Portion of total loss to be allowed in the feeders and mains.

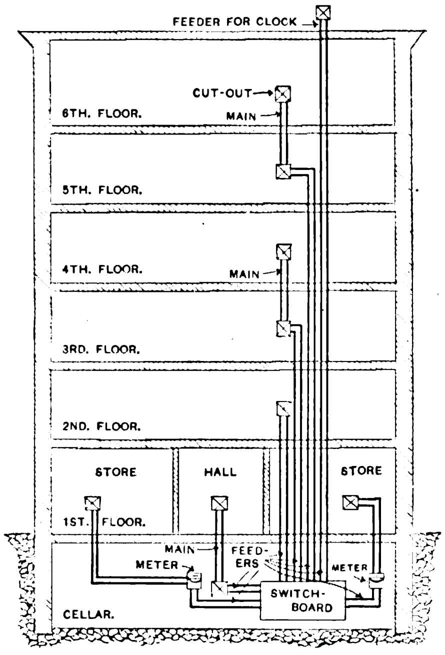
1. Control of groups of light (other than night or hall lights) from the main switchboard.

It frequently happens that it is desirable or even necessary to control the lights on each floor (or a portion thereof) from the main switchboard. Where such is the case, the feeder system must conform with this requirement and a separate feeder run to each floor (or group of lights).

In a large business building, for example, which is entirely or partly occupied by one concern having one or two different departments on each floor it is wise to make this provision, for the reason that one department may work longer or at different hours from the other departments, and therefore would require light at times differing from the other departments. Where this is the case it would result in a saving of current to be able to shut off the current from other floors just as soon as vacated, leaving current only on those floors where required.

An instance of such a case as this is a large insurance company in New York City, which occupies an entire building of eleven floors. As far as possible, each department is located on a separate floor. When one department does work after the others have gone, the feeder supplying current to that floor may be left connected to the switchboard, and the others may be disconnected. If the feeders were not so arranged, it would be necessary for the electrician to send to all the floors or departments connected to the same feeder which supplied the department working overtime, to turn off all the lights which the employees may have neglected to turn off when they left their work. In the case of a newspaper building, there may be certain floors where the light may be required all night, the occupants on the other floors going away at the usual time. Of course, it is expected that the occupants of the offices will turn off their light as they leave their offices, but this is not always done, and a saving of current could be effected by being able to shut off the current at the switchboard.

Where a business building is rented (as is frequently the case nowadays) with the agreement that electric light will be furnished at all times of the night and day, of course this arrangement of feeders is unnecessary. In this event, the feeder system may be laid out regardless of the control, so far as the room lights are concerned. In any case, however, it is well to have each of the lower floors, up to and including the ground floor, on a separate switch, as these floors require light at a greater number of hours and at more unusual times than the other floors.



Am.Elec.

FIG. 1.—ARRANGEMENT OF FEEDERS WHERE TENANT PAYS FOR LIGHT.

Wherever there is special lighting, such as the lighting of a clock dial, outside dome lights, or other decorative lighting, the lights should be provided with a separate distinct feeder controlled from the switchboard, because these lights are turned on and off at a set time from the switchboard.

In the case of a hotel, where the light may be required in any room at any time of day or night, of course this arrangement of feeders, so far as control is concerned, is of no importance, as it rarely happens that any of the switches controlling feeders supplying the bedroom floors are opened. They are closed the day the hotel opens, and are only opened in case of accident or other unusual circumstance.

Sometimes portions of buildings are rented on a contract basis, so that the tenant pays for the light he uses. In such cases, where there is a considerable number of lights, it is best to provide a separate feeder for each of these portions, so that a meter may be placed on the feeder and the current consumed measured at the switchboard. This frequently happens in a business building having stores or a restaurant on the ground floor.

Fig. 1 is an example showing a six-story building having two stores on the ground floor, each of which is rented on the basis that the current be measured and paid for, in addition to the rent, the upper floors being supplied with current at any time of the day or night, thus making separate feeders unnecessary; also having a clock on the roof provided with a separate feeder, so that the clock dial may be illuminated at dark and turned off, say at one o'clock. Here no provision is made for the separate control of hall lights, which is the next point to be considered.

(*To be Continued.*)

AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

PROTECTIVE DEVICES.

The matter of protecting telephone apparatus from the damaging effects of currents other than those which properly belong on telephone lines, is not such a simple matter as might be at first supposed. The "lightning arresters" found on nearly all telephone instruments are for the purpose of protecting the instruments only from what may be called extremely high tension currents, such as those produced by lightning. The usual form of this arrester is shown in Fig. 1, in which A and B represent the two line plates carrying two binding posts and forming the terminals of the instrument. The plate C is connected with the ground. These three plates are not in contact, the idea being that a charge of lightning will jump across the air gap to the ground plate before it will pass through the high resistance and impedance of the instrument coils within. They do some good, but are by no means infallible, as lightning has too many freaks to be kept out by any such simple device. The holes e, f and g are for the reception of a metallic plug, which, if placed in e, short circuits the instrument, and if in f or g, connects either one side or the other of the line to ground. The placing of the plug in the hole e affords a very efficient means of protecting an instrument during a storm, but it is subject to the very grave disadvantage that people will forget to remove it after the storm. If but one subscriber is served by a line, no one is hurt but himself, but if it is a party line, constructed on the bridging principle, the insertion of such a plug causes a dead short circuit which disables the whole line. Cases are very numerous where a repair man has had to drive perhaps twenty miles in order to tell a subscriber to remove his plug, for, obviously, the subscriber cannot be called up by telephone.

The next most simple means consists in placing in the telephone circuit a fuse-wire of very small current carrying capacity. These wires are usually mounted upon mica strips which may be inserted between clips forming terminals of the line and instrument wires. Although largely used, these have not proved at all reliable, but they often save an instrument when the one shown in Fig. 1 fails. Considerable difficulty is apparently experienced by the manufacturers of very small fuses in gaging them to blow at a given ampereage. I have frequently found ⅛-ampere fuses to carry two amperes without showing any signs of blowing. Again, inasmuch as these fuses are necessarily very fine, being not much larger than a hair, it is a very easy matter to break them, thus causing an open circuit the location of which may not be at once apparent. In the case of a high tension current these fuses usually blow, but frequently start an arc across the terminals, which does the damage to the instrument as effectively as if the line wire was continuous. Strange to say, an instrument is sometimes found burned out with its fuse still intact, although this is uncommon.

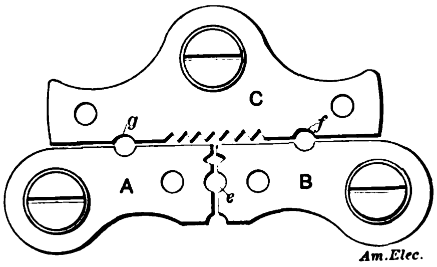


FIG. 1.—USUAL FORM OF TELEPHONE LIGHTNING ARRESTER.

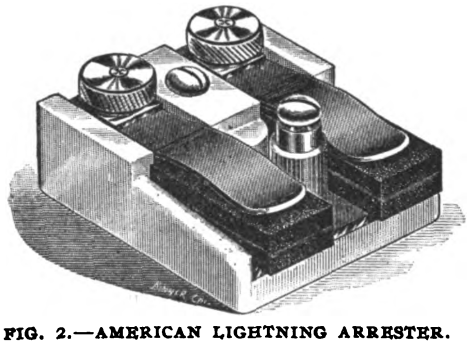


FIG. 2.—AMERICAN LIGHTNING ARRESTER.

Still another form of protector consists of two carbon blocks held apart by a thin disc of mica, one block forming the terminal of the line, the other being grounded. These blocks are usually arranged to slip in pairs between rather strong springs, so that they may be easily removed when desired. One form of these, shown in Fig. 2, represents the double carbon lightning arrester of the American Electric Telephone Company. The two binding posts at the top of the figure are attached to the two branches of the line, which are not cut, but run continuously to the telephone instrument, or whatever it is that is to be protected. The third binding post is in connection with the ground plate upon which the two lower blocks rest. The idea in this is that a current coming in over the line will jump across the very small space between the carbons and pass to the ground without harming the instruments.

The arrester shown in Fig. 3 is that used by the Western Telephone Construction Company, and is a combination of the carbon and the fusible arresters. In this the two line wires of a metallic circuit enter the two binding posts at the right of the cut, from which each circuit passes through the fuse-wires mounted on the mica strips, and then to the vertical springs bearing against the right-hand carbon block. These springs are respectively in connection by metallic strips underneath the porcelain block, with the two binding posts at the extreme left of the figure. The single binding post is in connection with the two vertical plates holding the carbons and is grounded. In this the fuse is supposed to blow for any current considered too great for the carrying capacity of the instrument, while, if the current is of a high enough tension to form an arc, it will jump to the ground between the lightning arrester plates. Some people advise connecting the fuse on the instrument side of the carbon arrester instead of on the line side, but this is not best; for, if there is a cable in the line and the cross occurs at some point beyond it, the current which would flow through the telephone instrument would, owing to the high ohmic resistance of the latter, not be strong enough to affect the cable; but, if the current jumps to ground through the carbon arrester a practical short circuit is formed which might allow a very heavy current to flow through the cable to the ground and thereby damage the conductor. For this reason it is better to have the fuse on the line side of the circuit.

The devices so far described have been designed to cut off all currents from the apparatus to be protected, above a certain maximum value. It frequently happens, however, that a very small current, due perhaps to a cross on the line, will not be sufficient to blow the fuse and will yet, by reason of a long continued flow, store up enough heat in a switchboard or ringer coil to char the insulation or burn it out entirely. These currents are the telephone exchange manager's worst enemies, and are very appropriately termed "sneak currents," because they usually pass all the protective devices placed in the circuit to arrest them, without producing any effect whatever; but, on reaching a close coil of wire, they, by slow degrees, develop enough heat to burn out the coil, or, as has frequently happened, to burn up the whole exchange.

A device to afford protection against such currents as these, types of which have come into almost universal use by Bell companies, is termed a heat coil and was, so far as I am aware, first introduced by Mr. Hammond V. Hayes of the Bell Company in Boston, Mass. This device is illustrated both in its assembled state and in its various details in Figs. 4, 5, 6, 7 and 8. In Fig. 7 is shown the details of the heat coil proper. A bobbin is formed of the two discs d and d¹, in the thin flat space x, between which is wound about 10 ft. of No. 32 B. and S. German silver wire. On the side d¹ is carried a metallic shoulder e and a flange 4, forming a deep groove f between them. A hole 8 is formed through the bobbin, through which projects a hard rubber pin s. The pin s is fixed in place by a small amount of easily fusible solder, which normally holds it in the position shown in the extreme left-hand portion of Fig. 8. One terminal of the German silver wire is attached to the flange e, while the other terminal is attached to an inclosing ring d² of brass. The flange 4 and the ring d² are thus insulated from each other, except for a path through the German silver wire w.

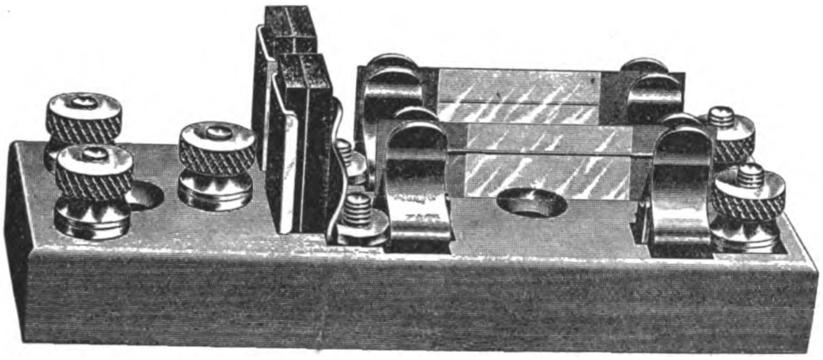


FIG. 3.—WESTERN TELEPHONE CONSTRUCTION ARRESTER.

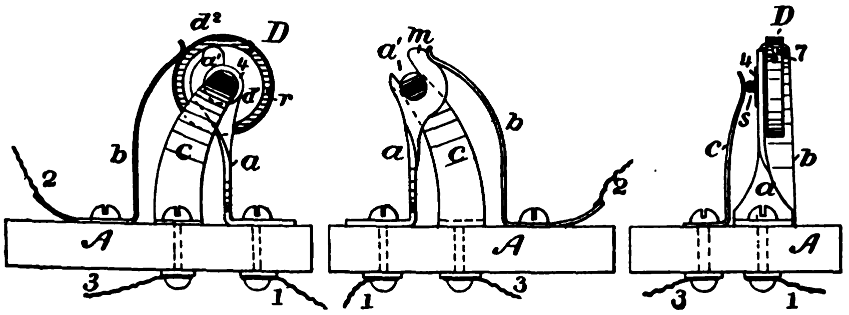


FIG. 4, 5 AND 6.—HAYES THERMAL ARRESTER.

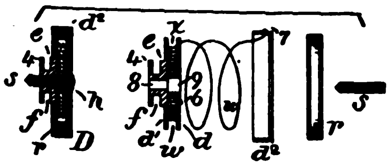


FIG. 7.—DETAILS OF HAYES ARRESTER.

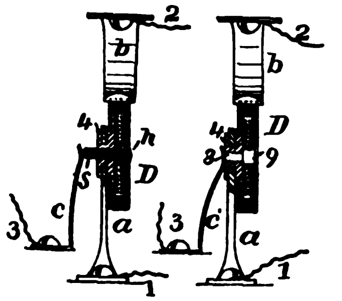


FIG. 8.—DETAILS OF HAYES ARRESTER.

Three springs, a, b and c, are mounted as shown, upon a base plate A. The spring a, which forms the terminal of the line 3, is slotted at a¹ in such manner as to receive the neck or groove f of the heat coil, as shown in Figs. 5 and 8. When in place, the spring b, which forms the terminal of the instrument to be protected, rests against the ring d², so that the circuit is complete from the line wire b through the spring a, flange 4, German silver wire w, ring d² and wire b to the instrument. When a current stronger than a certain predetermined value passes through the coil, a sufficient amount of heat is generated to melt the solder. This allows the spring c, which is connected by the wire 3 to the ground, to push the pin s entirely through the coil, so that contact is made between spring c and flange 4, as shown in the right-hand cut of Fig. 8. This at once grounds the line without leaving any air-gap whatever in the circuit, as in the previous arresters. It has been found advisable, however, to use these heat coils in connection with carbon arresters, and also with comparatively heavy fuses, as will be described later.

AN OPPORTUNITY FOR INVENTORS.

In every inclosed arc that burns there is a resistance in series which consumes from 75 to 150 watts, and in some cases even more. Arc lamp makers have striven to avoid the use of this resistance, but have finally yielded to the inevitable. It is necessary for purposes of regulation. In the 50,000 inclosed arc lamps now burning there is wasted over 5000 k.w. There is a market for some useful translating device that will absorb from 2½ to 5 amperes at 30 volts.

LESSONS IN PRACTICAL ELECTRICITY

HOW TO DESIGN A DYNAMO.

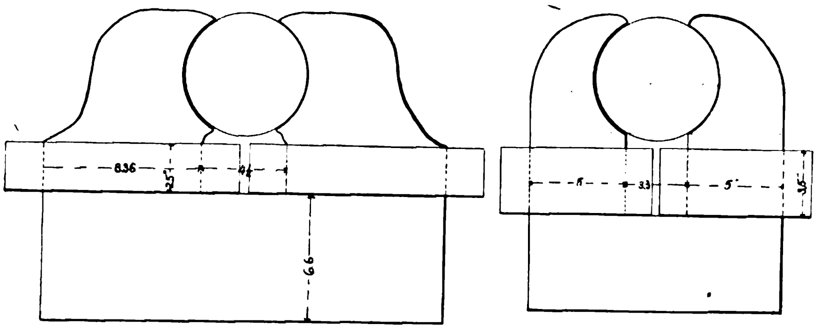
In the last article we determined that we needed approximately 3792 ampere turns in the field coils, and that the diameter of the magnet waists is 8.36 ins., if they are to be circular. We shall find it advisable to have the distance between the magnet waists quite small, not to exceed 4½ ins. This will allow us ½ in. in the clear between the spools and an available winding depth of 2 ins. Of this we must sacrifice at least .25 in. for insulation, leaving a winding depth of 1.75 ins. If we add twice the total depth available to the core diameter, we will obtain 12.36 ins. as a maximum diameter of a turn, and if we add twice the thickness of insulation to the core diameter we will obtain 8.86 ins. as a minimum diameter of turn. The average of these two gives us 10.61 ins., the mean diameter of turn. Multiplying this by 3.1416, we will find the average length of turn to be 33.4 ins.

It is now in order to explain a curious property of coils connected across a constant potential circuit. It is evident that if the coils are all of the same length their resistance is identical, provided the copper is of uniform quality. If we have, for example, ten coils, a certain current will flow and, if we multiply that current by ten, we shall have the total number of ampere turns that are available. If, without reducing the potential or the gage of the wire, we merely reduce the number of turns to five, we shall cut the resistance in two, thereby increasing the current to twice its former amount, and as we have divided the number of turns in two, the ampere turns remain the same. This can be proved to hold true universally, provided that the coil is not heated so as to vary its temperature and consequently the specific resistance of the wire of which it is made, and provided that the average length of turn is not altered. We may then lay down this rule for shunt coils: That their magnetizing power is dependent only on the average length of turn, the potential to which they are subjected, the gage of the wire and its specific resistance. It is entirely independent of the number of turns if temperature considerations are neglected. The latter feature must be determined by the amount of current that it is found wise to use in the coil, and sufficient turns must be wound on to reduce the current to an amount that the efficiency conditions will permit.

Acting on this rule, we may, for the purpose of determining the gage of the wire, suppose that we have but a single turn on the field spools, and that flowing in that turn is a current of 3792 amperes. This will give the necessary ampere turns. It receives its current from a potential of 110 volts, and its resistance must therefore be the volts divided by the amperes, or .029

.029 ohms. Knowing its length, we at once determine its resistance per foot to be .0104 ohms, and from a wire table we find that No. 20 Brown & Sharpe most nearly approaches this size. In a machine of this size the exciting current should not exceed 3 per cent of the total output of the dynamo. The total output is 55 amperes, and we must therefore keep the exciting current within 1.6 amperes. We must, therefore, provide enough turns on the field magnet so that their combined resistance, when placed across 110 volts, will produce this current. This we find to be 110 ÷ 1.6 = 68.7 ohms, which is equal to 2370 turns in all. We divide this number of turns by two to obtain the amount on a spool, as we shall have two spools. By previous calculation we found that we have an available winding space of 1.75 ins., and this will hold thirty-eight layers of double cotton No. 20 wire. To find the turns per layer we divide one-half of the total number of turns by the possible number of layers, and we obtain thirty-one turns. This will occupy a distance of 1.4 ins., to which we must add .6 in. more for spool heads and insulation. To this we must add an additional width for the series coil. This will consist of only a few turns of wire large enough to carry the main current, which is 55 amperes. This wire should be, however, quite large, not on account of its current-carrying capacity, but because we do not want to introduce an excessive drop in the dynamo circuit. No. 0 Brown & Sharpe gage is a suitable size, and as that is .36 in. in diameter insulated, it is wise to add to the length of the core ½ in. more to allow for a series coil of several turns, one turn per layer. This makes the total length of the spool 2½ ins. From the data we have already calculated we may now summarize the following:

1. Distance between magnet limbs, 4½ ins.
2. Length of magnet limbs, 2½ ins.
3. Diameter of magnet limbs, 8.36 ins.



FIGS. 1 AND 2.—APPROXIMATE FORMS OF FIELD MAGNET.

If we assume the yoke piece is to be rectangular in section and equal in width to the magnet core, its area must be the same as that of the magnet waists, which necessitates a thickness of 6.6 ins. It remains to make a drawing of this field magnet and examine it to see where it can be improved. Such a drawing is that shown in Fig. 1.

It will be observed at once that the magnet is very squatty and massive, and at first sight it seems too large for the armature it is to magnetize. We have, however, chosen a low density of magnetization in the field frame, and for this reason we have, in consequence, a large magnet and a small exciting coil. Copper is cheaper than iron, and hence the practice is desirable, where weight is not a consideration. We must further remember that the coils are circular, whereas the pole pieces would naturally demand a rectangular coil, due to the fact that they are somewhat elongated. The armature is 11 ins. long, and as we are looking at an end view of the field, its squatty appearance is thereby enhanced. The machine is 16 ins. high and the center of gravity of the armature is very low, which would make it run very satisfactorily and without vibration. The circular field coils are very economical in the amount of copper they use, whereas the rectangular field coils use slightly more; the circular field coils are also very easy to wind. On the other hand, a constructional advantage enters here. If the field coils are rectangular, the pole piece can be shaped so that the coils will slip over it, whereas if they retain their present circular form the pole pieces will overlap at the ends and therefore joints will be introduced into the magnetic circuit, which are very expensive to machine. Moreover, the poles are naturally much narrower than the diameter of the magnet waist, and they would be obliged to slope to reach its outer edge, as shown. Therefore, it is well to recalculate this frame, assuming a rectangular coil.

If we adopt this type of field frame, we shall find that the distance between the magnet waists becomes fixed, if each pole piece is to surround a third of the circumference and that distance is, of course, equal to the length of the chord of an arc equal to one-sixth of the circumference. The polar bore is 6.6, and the length of a chord spanning 60 deg. is equal to the radius, or 3.3, the available distance between magnet limbs. Of this we will allow .3 for clearance and divide the balance between the spools for winding depth. From the 1.50, thus allowed, we subtract .25 for insulation and have available for wire 1.25 ins.

The breadth of the core is obviously 11 ins., and as its area is 55.02 its width is 5 ins. The maximum length of turn figures out 44 ins., and the minimum 34 ins. The mean is 39 ins., and as its resistance must be by previous calculation .029 ohms, it is easy to determine that No. 19 B. & S. is the nearest standard gage which will fill these conditions. Now, 1.25 ins. will contain twenty-five layers of No. 19 double cotton wire and as there are 1185 turns per spool, there are forty-seven turns per layer. This will occupy a length of 2.4 ins. To this we add 1.1 ins. for spool heads and series coil and obtain a total length of 3.5 ins. for the field spool. A drawing of such a field frame is shown in Fig. 2, and the lines are very much more compact than those in Fig. 1, although the machine requires a little more copper to get the same magnetization.

The connection yoke below the magnet coils is rather thick, and its depth can be reduced by extending it into the base towards the bearing pedestals. The amount of this reduction can best be determined when the bearing pedestals are designed, but it will probably be equal at least to 25 per cent. The field frame is still quite heavy and could be still more reduced in weight by choosing a higher density of magnetization and winding on a more powerful magnetizing coil. This will impair the efficiency of the machine somewhat and would probably add to its total cost, as copper is more expensive than steel. We may therefore accept these dimensions as being satisfactory.

We now have a field magnet and armature which are approximately of the correct dimensions, and can accurately calculate the leakage and the necessary magnetizing turns, both for series and shunt coils. Our previous figures have been only approximate, but we may be reasonably confident that any changes which the more accurate calculations will entail will be of a minor character.

◆

Letters on Practical Subjects

The Cost of Feeding Boilers.

To the Editor of American Electrician:

Sir—I recently had a discussion with the engineer of a large plant regarding the cost and deficiency of several methods of injecting feed water into steam boilers. Like many other men this engineer was aware that the cheapest possible way of feeding a boiler was by means of a pump driven from the engine or from some convenient part of the shafting.

He also knew that it was rather expensive to feed with a steam pump, just how much more expensive he was not aware. For his information and for the satisfaction of other people who are interested, it may be stated that the triple expansion engines, run condensing, will use from 11 to 14 lbs. of coal per h.p.-hour, while the ordinary compound condensing engine uses from 14½ to 18 lbs. of coal.

The best Corliss engine in use, run condensing with a single cylinder, uses about 20 lbs. of coal; non-condensing, the same engine will use 28 to 30 lbs., while the ordinary simple engine, run non-condensing, uses 30 to 40 lbs. of coal.

The best steam pumps in the market, after they have been a few months in use, will rarely use less than 250 lbs. of coal for each and every h.p. generated per hour, but pumps usually consume more coal than this amount. It is not unusual for a pump to consume 400 lbs. per hour. This makes an exceedingly costly power, a thing which no engineer should tolerate.

He spends time and energy unlimited in increasing the efficiency of every part of his steam plant, but lets the old duplex pump bang away at the feed pipe and bleed the boiler one hundred-fold more than it should. A great deal more power is consumed in boiler feeding than the average engineer has any idea of.

Take for instance a 100-h.p. boiler where the engine is using 30 lbs. of steam per hour; figure out the amount of energy required to raise the amount of water consumed to the level of the boiler, and then to force it into the boiler against steam pressure, and it will be found that a great deal of energy is being consumed in the operation.

I will not discuss this matter in detail, but will content myself with giving a few hints, leaving the engineer to think out the matter at his leisure. First, there is a stated amount of h.p. to be used in putting the water into the boiler. Second, there is the choice of several methods of applying the necessary power. Third, there is the almost entirely neglected exhaust injector, which will feed a boiler without using either live steam or power from the engine—why this method is not universally applied is another question the engineer must answer. Fourth, there are other ways of feeding a boiler than by pump or injector. There are at least two appliances which force water into the boiler by gravity.

In practice each of these instruments has a vessel which is filled with water. Then the pressure on both sides of the liquid is equalized by the admission of steam, whereupon the water gravitates into the boiler. Fifth, the amount of steam used by these appliances—no data are at hand to determine the amount—it certainly cannot be more than once or twice the bulk of water injected into the boiler.

It must also be borne in mind that with both of these appliances, together with the injector family, all the thermal units contained in the steam, or nearly all of them, are returned into the boiler.

I would like to hear electrical station engineers discuss this matter. It is a question well worthy of being shown up in every possible light.

JAMES F. HOBART.

Water Rheostats.

To the Editor of American Electrician:

Sir: It was with considerable interest that I noticed the article by Mr. J. R. Perkins in your July issue, describing the water rheostat which he had constructed for use with his lathe.

I have found that while rheostats of this kind can be relied upon for experimental work which requires their use but a few moments, they are extremely unreliable when used for any length of time, on account of the fact that the resistance is constantly on the decrease, and this is particularly apparent where salt is used instead of acid.

During my lecture tours my operator has frequently burned out the rheostat which he used in connection with his stereopticon. It therefore became necessary for me to provide some kind of rheostat for immediate use, and in order to do this I constructed a water rheostat, using an ordinary water pail containing water and a little salt, the connection being made to two pieces of ¾ in. galvanized iron pipe, one being placed on each side of the pail and securely tied to it. While the operation of this rheostat was always excellent at the start, I found that in every case the resistance decreased so rapidly after the first fifteen minutes working that it was necessary to remove considerable of the solution from the pail and replace it with clear water in order to prevent blowing the fuse, which, as you can well understand, would have been a very unfortunate accident in such a case.

New York. W. J. CLARKE.

ELECTRICA CATECHIS

241. How can one instrument be used to measure currents in different circuits?

By having a double pole switch with several sets of terminals, like a voltmeter switch, the galvanometer may be connected around definite points on several circuits. It is necessary that the switch be made with great care, so as to have negligible resistance and so as to make sure and uniformly good contacts. If desired, the same galvanometer may be arranged so as to have a variety of ranges.

242. How can the range of current measured by a galvanometer be varied?

The range of the galvanometer may be varied by simply changing the ratio of the resistance of the coil with its connections, as compared with that of the "shunt." A given deflection or motion of the coil in the galvanometer is always caused by the same current; but that current may be any desired fraction of the whole curent in the main circuit, since the whole current divides itself between the "shunt" and the galvanometer circuit in inverse proportion to their relative resistances. If the resistance of either circuit is changed while that of the other remains constant, the ratio of the currents changes accordingly. Usually it is not desirable to change the resistance of the galvanometer circuit; the only alternative is to change that of the shunt. For a simple example, suppose that when the galvanometer is shunted around 1 ft. length of a bus bar or other conductor, 80 amps. give a full scale deflection of the galvanometer needle; if the same galvanometer is shunted around 10 ft. of the same conductor the relative resistances have changed so that the same current as before is sent through the galvanometer when the whole current is a trifle more than 8 amps. In the same way, if the galvanometer is shunted around 100 ft. of the conductor the galvanometer will give a full scale deflection when the whole current is a little more than 0.8 amp. The simplest way of finding the exact length of conductor to take as a shunt for a given range of current is to "cut and try," although the method of calculating it mathematically is not very difficult.

243. What is the difference between an ammeter and an amperemeter?

There is no difference; some prefer one word and some prefer the other. Amperemeter is more correct from an etymological standpoint, but most people seem to prefer the abbreviated form.

244. What is the difference between an ammeter and a current indicator?

A current indicator is usually a cheap form of ammeter whose readings are not claimed to be very accurate. For most plants it is not necessary to know the current exactly and a cheap ammeter is good enough. The voltage is the factor of importance, and it is better to put more money into a good voltmeter and less into the ammeter.

245. Is there any difference between a voltmeter and a voltameter?

Yes; there is a wide difference. A voltmeter is an instrument similar to an ammeter, except that it is arranged to measure voltage or pressure. The voltameter, on the other hand, is an instrument based upon the chemical effects of the current and measures the product of current by time. The Edison chemical meter is an example of a voltameter used to determine the ampere-hours of current used by a consumer.

246. What is the arrangement of voltmeters that have different scales corresponding to different binding posts?

Such instruments usually nave only one galvanometer coil, but have a number of different resistances in series. One terminal connects directly with the galvanometer coil; the terminal for the lowest scale is connected directly to the other terminal of the coil, or often to a small adjusted resistance coil in series with the coil; the next higher terminal connects with the circuit after it has passed through a second and higher resistance. The theory of the instrument is as indicated above in No. 246. A certain current is required to move the pointer to a certain mark; but the pressure or voltage necessary to send such current through the instrument depends upon the resistance of the circuit; hence each terminal governing the resistance in series with the galvanometer coil determines which scale shall be read for the true voltage.

QUERIES AND ANSWERS

Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied. The privilege of this department only extends to subscribers, and queries must be accompanied by name and address to secure attention.

What is the resistance of a standard telephone bell ringer? D. W. M.

The resistance of such an instrument varies, according to the maker, from 100 to 500 ohms.

I am running a 200-volt G. alternator, and the collector rings are cut very badly. It does no good to turn them down. What is the cause and remedy? W. B. P.

The cause is undoubtedly due to grit in the brushes themselves. Take your brushes off, clean them thoroughly and replace them. If you start with smooth collector rings they will probably remain so.

1. I have an electro-dynamometer which is wound with 150 turns of No. 30 copper wire, but is not sensitive enough. How can it be made more sensitive?

2. Do the lines of force increase in direct proportion to the ampere turns, if the circuit contains no iron?

1. Rewind the dynamometer with No. 36 copper wire.

2. Yes.

Will a gramme ring armature, wound and connected similar to Fig. 4, page 101, March number of the "American Electrician," operate in a field having any number of poles? A. P. K.

The armature referred to will operate in a field having any even number of poles, provided that there are as many brushes applied to the commutator as pole pieces and that alternate brushes are connected together.

Can I charge a storage battery from an arc circuit running 30 lamps at 8½ amperes? C. K. B.

Yes, provided that the charging rate of the battery is equal to or greater than 8½ amperes. The current that the battery absorbs may be varied by shunting a resistance around it. An ammeter placed in the battery circuit will show how much current is flowing, and this should be varied according to the regular methods in charging storage cells.

What is the resistance of the fields and armature of an ordinary 25-h.p. railway motor? Also the amount of resistance the controller cuts out at each move of the handle? C. W.

The resistance of such motors varies. The following are average figures: Fields, .84 ohms.; armature, .78 ohms. The resistance in the controller handles should be such that when the motor is stationary the current should not exceed 120 amperes, the volts being 500. It should be cut out in equal sections.

In a 3-phase converter, what is the cause of the e.m.f. current sometimes being displaced in phase? I. R. T.

If your field of the converter is weak, the back e.m.f. will be correspondingly small and the armature winding will act as an inductive resistance, which, of course, displaces the phase of current and e.m.f. By strengthening the field this displacement may be corrected and reduced to zero, or the phase may be displaced the other way, causing what is known as leading currents.

1. Will an X ray coil work on alternating currents?

2. Is an alternating current good for cautery purposes? S. J. S.

1. Yes. Omit the vibrator and send into the coil pulses in one direction only, cutting out the others by means of a suitable commutator, driven either by a synchronous motor or by direct connection to the alternator shaft.

2. In cauterizing a heated wire is used, and it is only necessary that the wire be sufficiently heated, therefore an alternating current will answer excellently.

Numerous bicycle lamps have been advertised which are fed by means of a little dynamo driven by the wheel and which keep constant voltage whatever the speed. What devices do they use to obtain this result?

There are a number of devices that can be used. The field magnet of the dynamo might be wound with a demagnetizing coil, which reduces the strength of the field as the speed increases, thus keeping the voltage constant. Again, the armature might have several coils which would successively be cut out by means of a suitable centrifugal governor as the speed increased. Both of these devices have been used.

1. How many feet, and what size of German silver wire will it take to build a small heater to boil coffee upon, to be used on a 52-volt circuit?

2. We have a 2-horse power motor which we wish to use as a dynamo. How many 16 power lights will it carry? L. A. V.

1. Your heater will require about 400 watts, and will take 8 amperes at 50 volts, which resistance should therefore be about 6 ohms. About No. 20 wire, Brown and Sharpe, should be used, and of this there will be required about 45 ft. This will generate heat enough, if properly applied, to boil a quart of water in 5 or 6 minutes.

2. About 20 lights.

I wish to charge a storage battery with a shunt wound dynamo by wind power. What instruments should I use so that the battery e.m.f. will not force current into the dynamo when the latter is runnng too slow? D. W. M.

Use a cut-out which is held closed by means of a magnet in shunt to the dynamo. When the e.m.f. of the dynamo falls the cut-out will fall open, and when it rises to the proper value it will close again. Such a device must be accurately adjusted, for it must fall open and must close at pressures the difference between which is about 20 per cent of the battery voltage. Often a series coil is added, so connected that a current from the battery to the dynamo will oppose the shunt coil.

I have an automatic switch, which opens and closes the circuit continuously under the action of an electromagnet, the current in which is automatically interrupted by suitable means. After running for an interval the magnet seems to lose its grip; it will not pull as hard and its range is notably less. If allowed to remain idle for a while, when used the magnet will regain its former strength. Does the iron of the magnet become exhausted after repeated use, and, if not, what is the cause of this? A. L. S.

The reason probably is that the wire in your magnet becomes heated, due to continuous working, and its resistance in consequence rises. While it is in this condition less current can enter the magnet with a given voltage, and its pull, of course, will be less. As soon as it becomes cool it regains its former strength.

1. What are the advantages of two-phase currents over single phase?

2. Describe the action of a rotary transformer. A. B. W.

1. The advantage of two-phase over single-phase currents lies in their ability to operate alternate-current motors. There is no satisfactory single-phase motor at the present time.

2. A rotary transformer armature is connected exactly as a direct-current armature and its field excitation is similar. At equidistant points on the winding there are led in 2, 4, 6, 8 or 12 leads, the number of leads being dependent on the number of poles and the number of phases. Alternate currents are led into the armature and distribute themselves through the wires in such a way as to drive the machine as a motor. The current distribution is uneven in the various wires on the surface of the armature, some of the wires serving to drive, some being driven; but the potential difference at the places where the direct-current brushes take off the current is practically constant, and equal to a function of the alternate-current voltage supply.

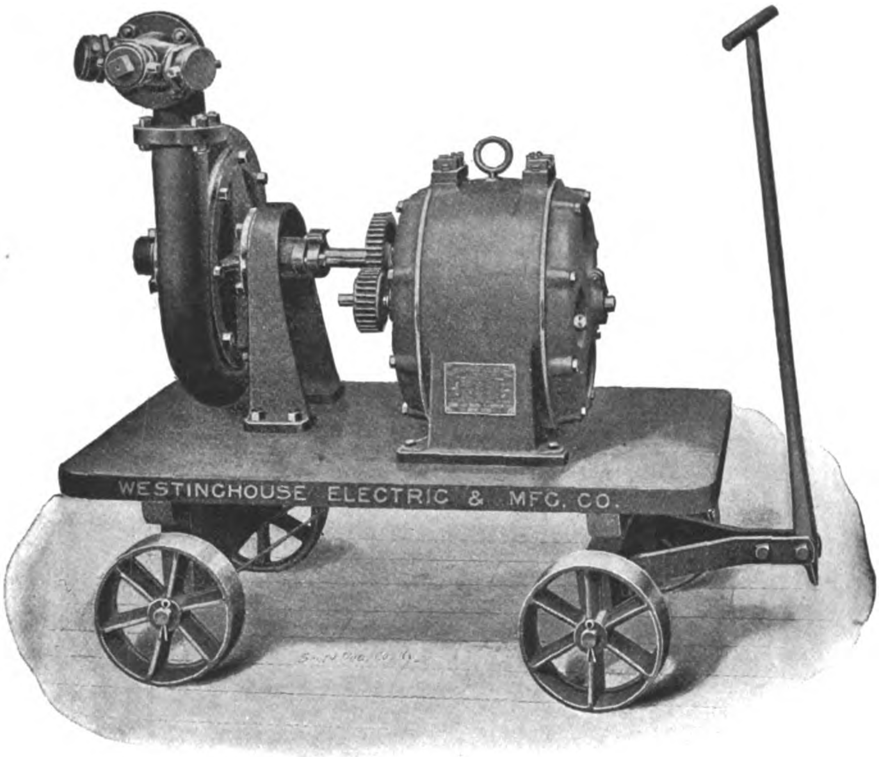
I have a T-H arc dynamo, which has suddenly ceased to work properly. On starting it will give eight amperes, the controller magnet seeming to work perfectly. After the machine has been running the current drops to five amperes, and it is not possible to get more. The controller magnet gives no sign of moving. The machine has been thoroughly tested with the magneto for short circuit. The connections appear to be tight and clean, and the speed is what it should be. H. A.

Lower the controller arm by hand and see if the current increases to nine amperes, as it should. If it does, the trouble is in the controller mechanism. If the controller magnet is all right, look at the wall controller. Make sure that the contacts on the wall controller are clean. It may close circuit apparently, but fail to shunt the machine solenoid and cause it to drop its plunger. If the controller is all right, it may be that the machine is overloaded; that there are too many lamps on the circuit; and that its voltage is therefore not sufficient to force nine amperes through them. The overload may be some fault in the line, or in some of the arc lamps. Frequently a dirty commutator, even, on an arc machine, will cut down its voltage capacity. On a Brush machine this has been known to reduce the voltage output 100 volts.

Apparatus and Appliances

A PORTABLE ELECTRIC PUMP.

An interesting application of electric power is illustrated in the accompanying cut, in the form of a portable electric pump. This combination has been designed to be used in the California Winery, of Sacramento, but it is one that may be applied to other purposes where fluids are similarly handled. The outfit consists of a Westinghouse alternating-current induction motor of 2 h.p.-capacity, direct-connected to a centrifugal pump. The machines are mounted upon a suitable truck, whereby they may be transferred from place to place for the purpose of pumping wine from one vat into another. Receptacles for the electrical connections are provided at convenient points throughout the building, to which the motor is connected by means of flexible cables. The power is taken from the circuits of the Central California Electric Company, and is generated at Newcastle, 30 miles distant from Sacramento. The simplicity of the pump and motor render them ideal in construction. The motor has neither commutator nor brushes; there is no connection between the revolving part and the electric circuit. It may be handled by the most inexperienced persons with perfect safety.



PORTABLE ELECTRIC PUMP.

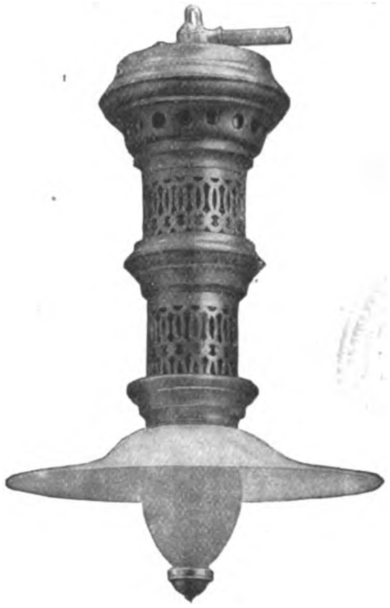
The centrifugal pump is adapted to handle liquids under most difficult conditions, even though they contain 20 to 40 per cent of solid matter and are at high temperature. Thus, it will be seen that the applicability of the device may be extended to the more arduous duty of pumping muddy accumulations in electric subway manholes, tannery liquids, dyes, bleaching solutions, vinegar and brine, liquids used in pickling, and is otherwise applicable to a multitude of services in the arts. The combination is the production of the Westinghouse Electric & Manufacturing Company, of Pittsburgh.

A MINIATURE ARC LAMP.

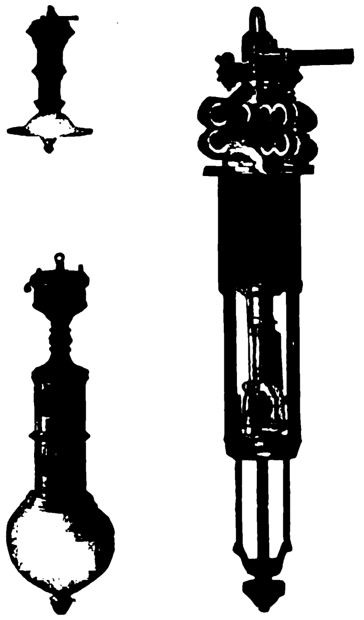
The inclosed arc lamp has been the cause of a considerable extension in the arc system of electric lighting, and the miniature arc lamp of the General Electric Company promises yet another advance in electric illumination. For interior use the objection to the arc lamp has been that the light has been too concentrated. With low ceiling rooms, such an intense light over-illuminates the parts directly beneath it, while the other localities of the room are left comparatively dark.

In the new lamp, herewith illustrated, the illuminating power and the current consumed are much less, so that several smaller lamps, which are not more expensive to operate than one large lamp, may be used to much greater advantage. It is of the single globe and reflector type, the light of the arc being thrown down from the polished surface of the reflector. This lamp was designed for 110-volt direct current circuits, and in view of the fact that it is frequently required to operate at higher or lower voltages it has been provided with adjustable resistance, which adapts it for any voltage from 100 to 120. The standard current required by this lamp is 2½ amperes, but a loop in the magnet coil permits an adjustment for 3 amperes. The potential at the arc is from 73 to 75 volts, and when adjusted for 2½ amperes, with a line voltage of 110, the energy at the terminals is 275 watts, and for 3 amperes the energy is 330 watts. The life of a trimming is from forty to forty-five hours with standard current and from thirty to forty hours with 3 amperes.

The mechanism of this lamp operates on the well-known General Electric carbon-feed principle. The carbon passes through a brass tube extending through the center of the magnet coil, and is fed by a double cam clutch operating directly upon it. Special attention has been given to the design of the holders and general arrangement of the frame to permit of rapid trimming. The principal dimensions of the miniature lamp are: Length over all, 18½ ins.; inclosing globe, top diameter, 2 ins.; maximum diameter, 3 ins.; porcelain shade, 4 ins.; weight, 9½ lbs. No outer globe is used. Each lamp is provided with a cut-out switch.



MINIATURE ARC LAMP.

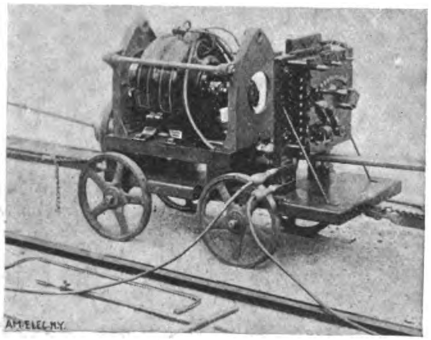


MECHANISM OF MINIATURE ARC LAMP.

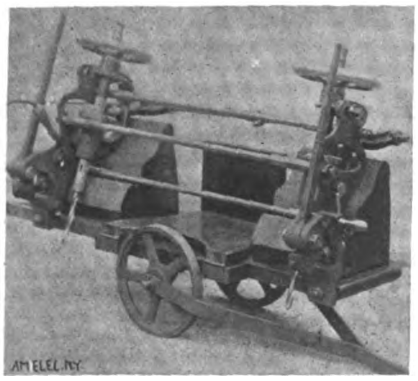
Several hundred of these lamps have been introduced among central stations within the past sixty days, and if increasing demand is a criterion they have been favorably received.

AN INGENIOUS DRILLING DEVICE.

In the accompanying illustration we show a portable electric drill, which is used by the Harrington Rail Bonding Company, of New York, for installing their diagonal bonds. This equipment consists of a 500-volt Lundell 3-h.p. motor and standard automatic starting box provided with an electro-magnetic release, mounted on a little truck. It receives its current from the overhead trolley through one lead and conducts it to the rail by the other. These leads are simple flexible wires tipped with handles carrying plugs which can be readily disconnected. This truck is connected with two other trucks by very long space bars sufficiently long to span a thirty-foot rail. On the other two trucks are mounted the drilling devices which are shown in Fig. 2. The motor is geared to a shaft beneath it, from which extend two telescope shafts with universal joints, which supply power to the two sets of drills. On each truck are mounted two drills provided with means of feeding by screw pressure. In this way four holes can be drilled at a time, which provides for two bonds. The bond used is what is known as the diagonal type, which connects with the rail at the junction between the lower flange and the web, where there is considerable metal, and where a hole so drilled at an angle will expose a considerable area of contact, more, indeed, than in any other part of the rail. The angle at which the drills are manipulated is such that it is only necessary to remove a single paving block to drill the hole, and a single row of paving blocks to install the bond. The drilled holes are accurately reamed to fit the conical terminals on the end of the bonds, which are then very tightly driven into place by means of a suitable tool. In this way the contact is sure, electrically and mechanically. By means of this and other ingenious devices the Harrington Rail Bonding Company can install their bonds with great expedition, and at the same time in a most thorough manner, and as the installation is a very large proportion of the cost of bonding, this should interest street railway managers.



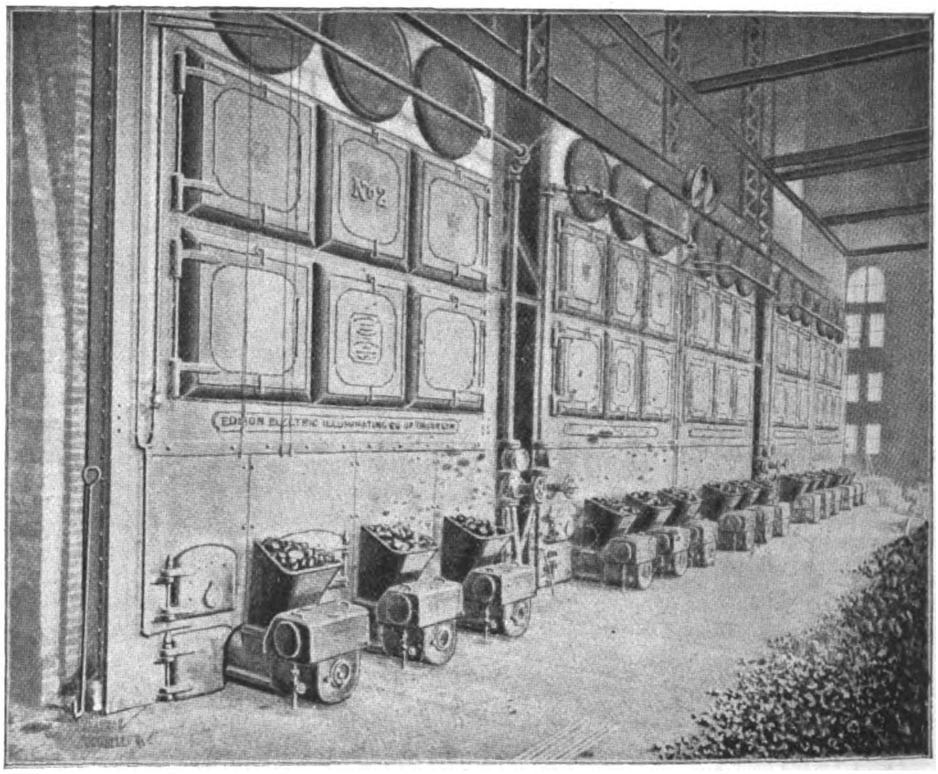
PORTABLE DRILLING MOTOR.



DRILL PRESS FOR PORTABLE MOTOR.

A MECHANICAL STOKER.

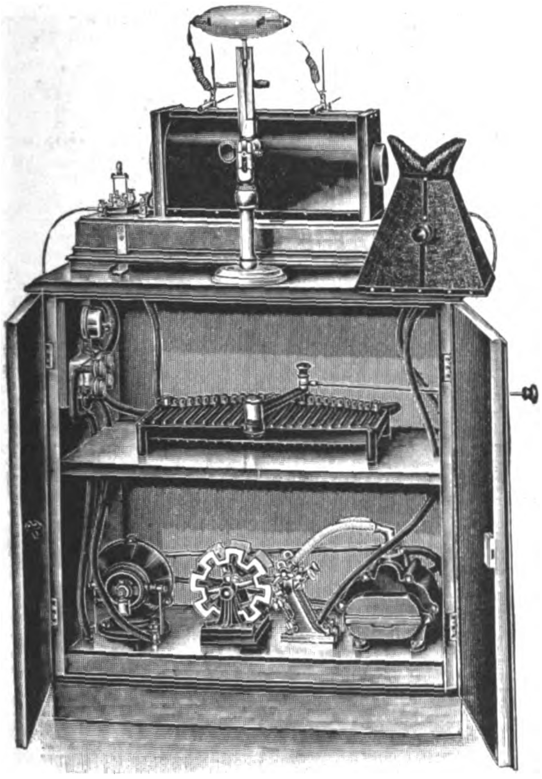
In the accompanying cut is shown an underfed mechanical stoker system in the boiler room of the Edison Electric Illuminating Company's station at Brooklyn, N. Y. This plant is to have an ultimate capacity of 60,000 h.p., but at the present time only one-fourth of the apparatus has been installed. The boiler room is 198 ft. x 46 ft. and is equipped with 500 h.p. boilers of the Cahall water tube type, each furnace being supplied with three stokers, independently driven. The slack coal used for fuel is carried from the dock by cars to storage bins, from which it is lifted to smaller bins just above the boiler floor. From these it is distributed through chutes to several conveyors, which carry it to the stokers. The chutes leading from the boiler house bin terminate in weighing apparatus, which registers the amount of coal that passes. Immediately beneath the coal hopper is a conveyor pipe which communicates with the coal magazine placed in the furnace. A screw conveyor, or worm, is placed in this pipe and extends the entire length of the magazine. The wind box is located beneath the conveyor pipe, and has an opening beneath the hopper through which the air supply for the furnace is forced. The other end of this air box opens into the air space between the outer casing and the magazine, the upper edge of which is surrounded by tuyeres, or openings for the discharge of air. Each stoker is entirely independent, being driven by a small steam motor located in front of and beneath the hopper. This motor has a simple recipracating piston which is connected so as to turn the conveyor shaft, which forces the coal into and through the magazine. The rate of feeding coal is controlled by the speed of the motor, which in turn is controlled by throttling the steam supply. The coal, after being fed into the hopper, is carried by the conveyor into the magazine, from both sides of which it overflows and spreads out upon the surface of the grates. The operation is continuous, and as the coal approaches the fire it is roasted and delivered as coke on the grates above, the gases which are thus released mingling with the fresh air entering through the tuyeres and becoming ignited. Every pound of coal fed into the hopper is subjected to this gas making process, and there is no loss of coal through grates by reason of the use of dead grates in the furnace in place of open grate bars. This method of igniting completely consumes all the combustible components of the coal, and the stacks are almost entirely smokeless. These stokers were manufactured and installed by the American Stoker Company of New York City.



A PLANT OF MECHANICAL STOKERS.

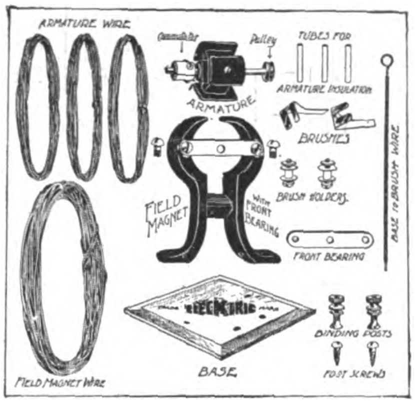
A HOSPITAL SHIP X-RAY OUTFIT.

The U. S. Navy hospital ship "Solace" has been equipped with a portable cabinet X-ray outfit, which is herewith illustrated. The cabinet is made of quartered oak of massive construction and occupies a floor space of 2 ft. 8 ins. x 1 ft. 8 ins., and is provided with four wrought iron angles screwed on to its base, by which it can be rigidly fastened to the deck, to prevent damage in heavy weather. The coil is similarly mounted on top of the cabinet, to which it is secured with brass angles, and the base of the adjustable focus tube stand is similarly screwed to the top of the cabinet. The upright part of the stand has a wooden screw by which it is attached to the base, and which permits of its removal when that is desirable. A distinctive feature of the outfit is the absence of the vibrator on the induction coil, its place being taken by the instantaneous air break wheel device shown in the bottom of the cabinet. This consists of two toothed wheels mounted on the same shaft. The teeth make contact with two flat brushes, which bear upon the outer peripheries through which the current enters and leaves. These wheels are rotated at high speed by a small direct-current motor, which also runs a pressure blower. The air blast from this blower enters a bifurcated tube and is conducted to two flat nozzles immediately over the contact brushes. When the machine is set in operation by starting the motor, the primary of the induction coil is connected in series with the breaking device, the spark at the contact brushes is blown out by the air blast, very much shortening the time of breaking circuit and correspondingly increasing the rapidity of the demagnetization of the core. This very much augments the e.m.f. of the secondary coil. The controlling rheostat is shown on the upper shelf of the cabinet and is used to vary the current in the primary coil. The lever arm of the rheostat is connected to an extension rod so that it may be actuated from without. The main switch is situated on the left hand side of the cabinet near the top and the cutouts directly underneath. The enclosed arrangement of the apparatus is an advantage, as it is impossible for unauthorized persons to use the apparatus. The coil is protected by a polished oak cover, not shown, which entirely protects the apparatus when not in use. In cases where the patient is seriously wounded, and it is necessary for him to maintain a reclining position, the focus tube is attached to a portable holder, shown in Fig. 2. The holder is made of rubber, so that it can be handled easily and without fear of shock to the operator. Special heavily insulated wires are provided for connecting. In use it is placed underneath the cot or operating table, and the surgeon makes his examination by looking through the patient from above. The apparatus is portable and can be provided with heavy casters to enable its ready removal from place to place. It is connected with the source of power by an attachment plug and cord, which may be screwed into a convenient receptacle or socket. The construction of the apparatus is very thorough, and it is said to be very satisfactory. It is manufactured by the Edison Manufacturing Company, of New York City.


X-RAY OUTFIT.

MOTOR FOR AMATEURS.

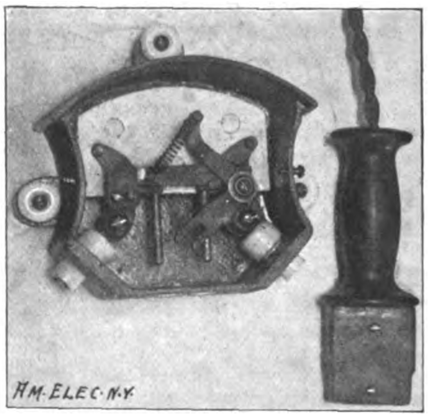
The Knapp Electric & Novelty Company of New York is manufacturing a small motor, intended for amateur use, which is sold complete for one dollar, and the parts of which are shown in the accompanying illustration. It consists of a three-pole armature, which will start from any position without assistance. It is claimed to be a considerable advance upon the motors usually sold for that low price. Many students and amateurs prefer to purchase and assemble the parts of small motors rather than to secure the complete machines, and the Knapp Company is prepared to fill all demands of this character. The company produces larger motors as well—namely, types B, C and D, which are designed for driving fans or light machinery. In the two larger types drum armatures are used, which render them suitable for continuous running on power circuits.



SMALL MOTOR PARTS.

A NEW ARC CUT-OUT.

The apparatus herewith illustrated has been especially designed to meet the demand for a cut-out that can be used on iron poles carrying high voltage currents. The construction is such that by manipulating the handle to which the cable is attached, the loop is first closed and then entirely disconnected. In cutting them in again the motion of the handle is reversed, which first short circuits the loop, and then opens it into the main current. The spring, which is attached to the top of the arm and to the outer end of knife blade is the operating force on the switch jaws, and when given a tension by the handle it moves the jaws with a quick motion entirely beyond the control of the operator. These cut-outs are finding great favor, both in central stations and for pole use in street lighting. They are manufactured by the Philadelphia Electrical & Manufacturing Company, of Philadelphia, Pa.



NEW ARC CUT-OUT.

THE LARGEST DYNAMO IN THE WORLD.

The rapid development of electric power for various purposes has made a demand for larger and larger units in the generating stations where this power is produced. A few years ago generators of 100 to 200-k.w. capacity were considered enormous machines. There soon appeared, however, direct-driven generators of 750 k.w., to be used in large railway plants in such cities as Chicago, Boston, St. Louis and Brooklyn. At the World's Fair, in 1893, the first 1500-k.w. generator made its appearance in the Intramural Railway station. This machine was then considered a monster. This unit was soon adopted for many of the large street railway stations, notably in Chicago and Boston, and finally machines of 1600 k.w. were placed in the Kent Avenue station in Brooklyn. Still later Louisville, Ky., purchased a 2200-k.w. generator. The Metropolitan Street Railway Company, of New York, has recently placed an order for a number of 2500-k.w. alternating machines, and but a few months ago the Boston Elevated Railway Company, which succeeded the West End Street Railway Company of that city, gave to the Walker Company, of Cleveland, the order for a 3000-k.w. machine.

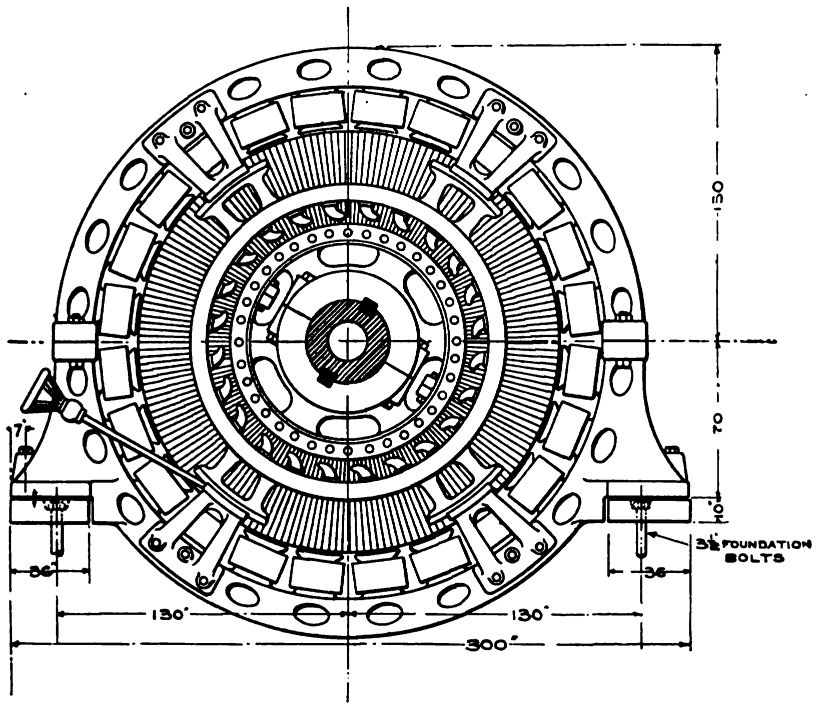
All of these large machines are made to run at the very slow speed of from 75 to 80 r.p.m. The alternating current machines built for the Cataract Construction Company at Niagara Falls have an output of 5000 h.p. each, while that ordered by the Boston Elevated Railway Company has an output of but 4000 h.p. Nevertheless the 4000-h.p. machine being built by the Walker Company is much larger than the alternators in use in the Niagara Falls power house, because the speed of the Boston machine is 75 r.p.m., while that of the Niagara machines is about 300 r.p.m.

If the Boston machine were run at the speed of the Niagara machines its output would be something over three times that of the latter, or about 16,000 h.p.

As the construction of this 4000-h.p. generator marks an era in the development of dynamo-electric machines, it may be interesting to electrical engineers and those using electrical apparatus, to know its dimensions and general design. We therefore devote some space to its illustration and description.

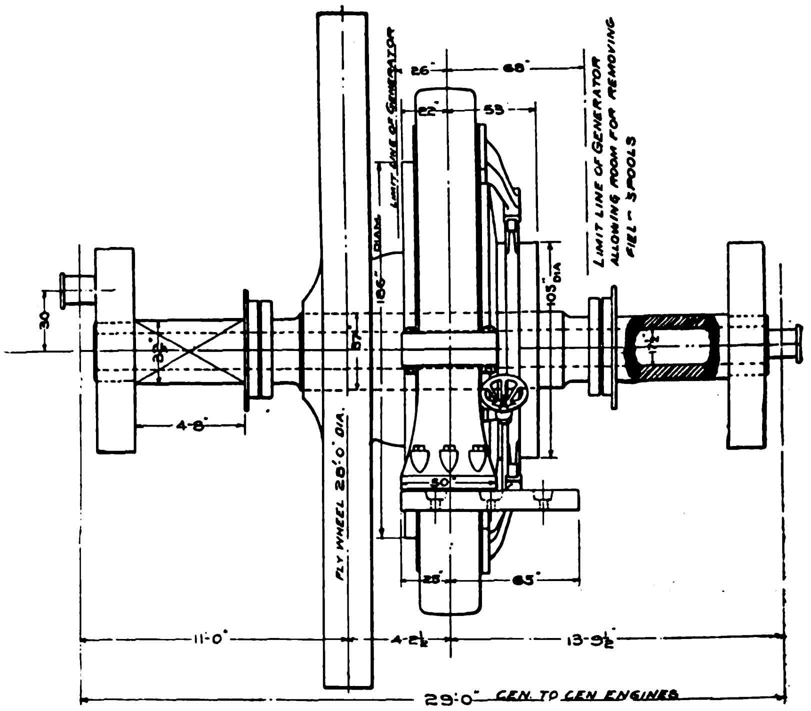
The total weight of the complete machine is 250,000 lbs. The frame is made of cast steel and is circular in form, the diameter over all being 21 ft. 7 ins. The weight of the frame alone, without the field magnet cores for magnet spools, is 50,000 lbs. To the inside of the magnetic ring or frame are bolted twenty-four laminated steel magnet cores or pole-pieces, the total weight of which is 30,000 lbs. The inside diameter of the bore of these pole-pieces, completed, is 15 ft. 6 ins.

The magnet cores are each provided with spools wound with shunt and series coils in the usual way. The pole shoes are arranged to hold the magnet spools in place and each core is bolted by four 3-in. bolts to the inner surface of the magnet frame. The magnet frame is divided in halves, on a horizontal plane, and is mounted upon the foundation plates in such a manner that the whole frame may be made to slide lengthwise of the engine shaft far enough to uncover the armature windings, or to allow the individual magnet cores or field spools to be removed without separating the magnet frame.



SIDE ELEVATION OF GENERATOR.

The armature spider of this machine is made in halves, like the hub of a fly wheel, to be bolted together upon the shaft of the engine after it reaches its destination. If it had been made in one piece no railway car could be found large enough to ship it from Cleveland to Boston. The armature hub weighs, complete, 40,000 lbs., and has an outside diameter before the laminations are in place of 13 ft. After the engine is upon its foundations in Boston this armature spider will be mounted upon the engine shaft, which is itself 37 ins. in diameter. The laminations which form the armature core, the total weight of which is 30,000 lbs., will then be built upon the periphery of the armature spider. The slotting in the armature laminations will register accurately, and provide, when completed, 594 slots. The insulation and windings will then be fitted into the slots and connected with the commutator.



END ELEVATION OF GENERATOR AND SHAFT.

The commutator itself is made up of 1188 bars and is 105 ins. in diameter. It is divided into halves for the purpose of shipment and ease of handling, and will be placed upon an extension of the armature hub after the latter is secured to the engine shaft.

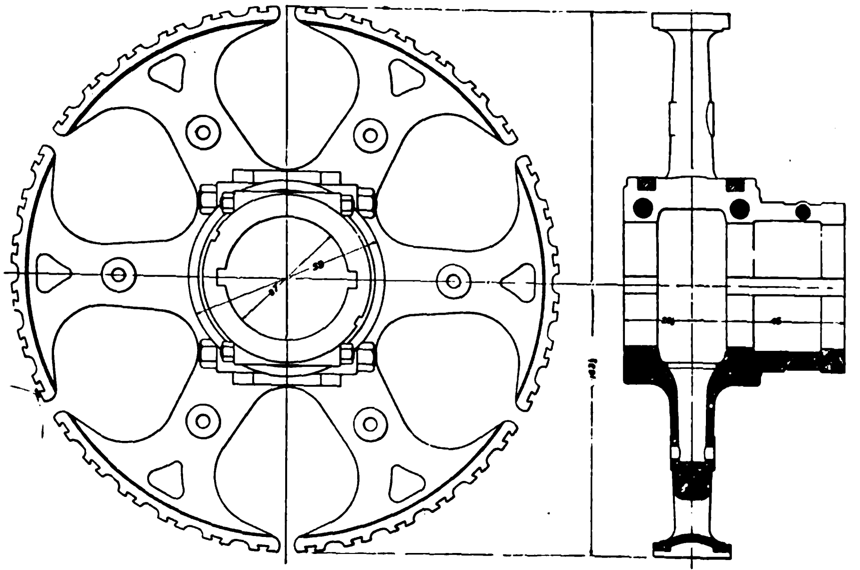
The fly wheel of the engine will be bolted directly to the armature hub near its periphery, in order that the regulating force of the wheel shall not be transmitted wholly through the shaft of the engine. This will relieve the armature shaft and its keys from strain to which they would otherwise be subjected.

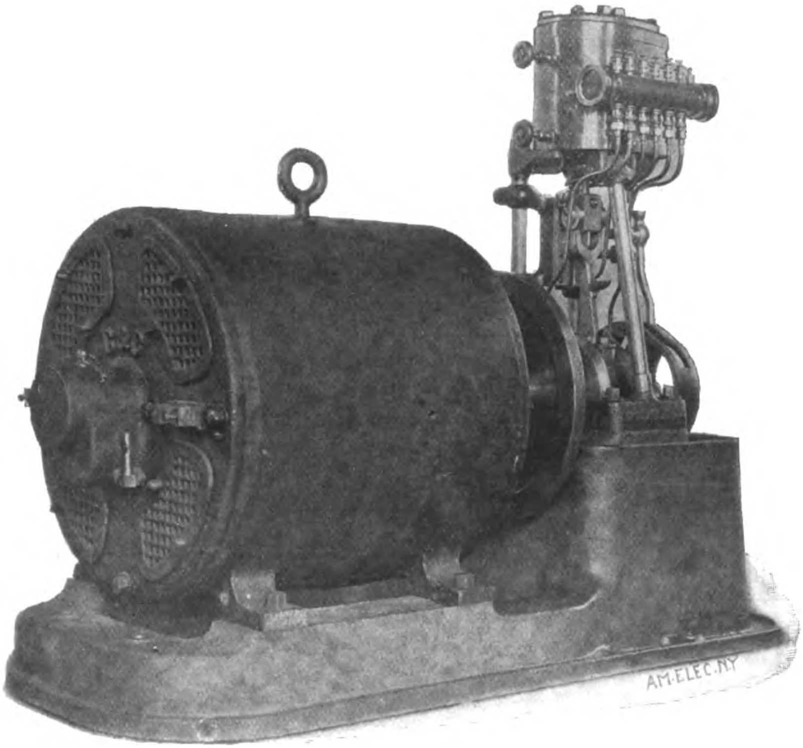
The machine has been most carefully designed and an unusually large factor of safety provided for every part subjected to mechanical or electrical strain. Because of this the machine will be able to take twice its normal load for short periods of time without injury, and to carry a 50 per cent overload for several hours.

The greatest care has been taken to secure from the generator a higher percentage of efficiency than has thus far been attained in units of large size.

A MARINE GENERATING SET.

In the accompanying illustration is shown a 3-k.w. C & C ironclad dynamo direct-connected to a Forbes engine. This generating set has been recently installed in one of the vessels of the Boston Towboat Company for lighting purposes. The outfit is claimed to be an ideal type for marine use, as it is very light and its ironclad construction renders it impervious to moisture, important considerations in electric machinery for installation on small crafts which often encounter rough weather. These sets are supplied in various capacities ranging from 2½ to 15 k.w. In the larger sizes the dynamos are direct-connected to the Case vertical engines, and two of these units are now being built for the United States Government. These units are very compact, they are mounted on a single sub-base and provided with self-oiling bearings, and are otherwise constructed so as to require a minimum of attention.

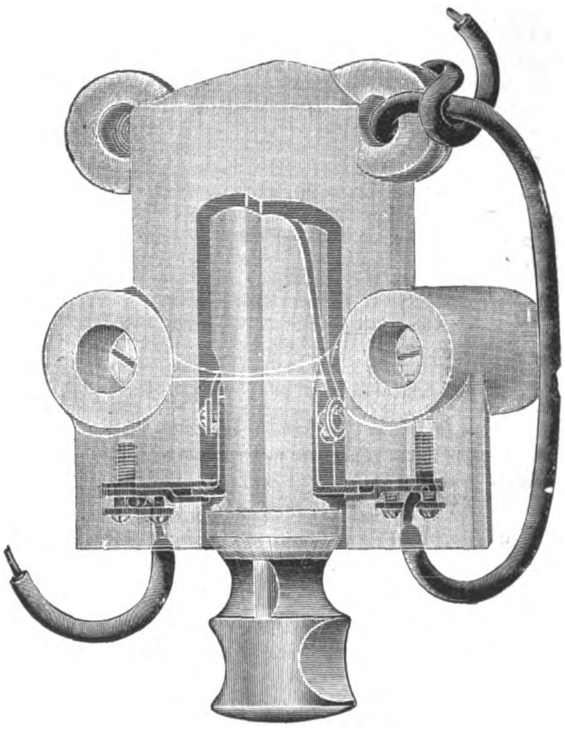

SIDE AND END ELEVATION OF ARMATURE SPIDER.



A MARINE GENERATING SET.

A CONVENIENT HIGH VOLTAGE FUSE BOX.

The accompanying illustration shows a convenient and substantial junction box and motor cut-out. It is built entirely of porcelain and contains an ample fuse chamber. It will accommodate a 5-in. fuse. The fuse is bent around a plug which is thrust into the socket provided for it, and connected into the electrical circuit by means of a quarter turn. The plug can be removed and safely replaced. It is fastened to its support by lag screws or wood screws, which are furnished with the cut-out. I is very conveniently adapted for making proper wire connections, and especially recommended for 500-volt motor and for transformer service. The utility of the device is apparent at once on inspecting the cut, and its simplicity and low price have found it many friends among those who do consruction work. Messrs. Pass & Seymour, of Syracuse, who manufacture this article, find the demand for it very brisk. It is particularly well adapted for primary circuits working at pressures as high as 2200 volts.


HIGH VOLTAGE FUSE BOX.

NEW BOOKS.

The Electro-dvnamics. The Direct Current Motor. By Charles Ashley Carus Wilson, M. A. Longmans, Green & Company. 298 pages, 71 illustrations. Price, $1.75.

This book is a contribution to dynamo design. It sets forward the author's methods in concise style, and frequently illustrates by practical example. Like most dynamo designers, the author has methods of his own which he uses in preference to others. The aim of the book is particularly to discuss direct-current motor design. The writer has taken for granted a certain acquaintance with the use and design of motors, but as the book is intended to have a general service to engineers, unexplained technicalities have been avoided as far as possible. In addition to the instruction in dynamo design which the book contains there is also a great deal of valuable data, the outcome of the practical experience of engineers.

Electrical Testing for Telegraph Engineers. By J. Alton Young. 249 pages, 91 illustrations. E. Van Nostrand & Company. Price, $4.00.

This book was prepared with a view to supply the want felt by submarine cable electricians, and is devoted exclusively to their work. In carrying this out, however, the subject of overland line testing has necessarily been included as a part of the study; the same theory applies to both, the difference being merely a practical one and consisting simply in the fact that the refined measurements necessary in cable testing have been largely dispensed with in aerial line testing.

The localization of faults has been very fully investigated, including the different degrees in which the various methods are affected by the presence of a second fault, or general leakage. The reader is presumed to possess a slight prior acquaintance with electrical science and to understand elementary mathematics. Although the book is written with the idea that the student is cognizant of electrical matters to some extent, yet wherever there seems to be a doubt in the matter he is given the benefit thereof, and the apparatus or theory employed in the method of testing is described or explained. Aside from the reputation which its author's signature affords, it has been reviewed before publication by other prominent electricians, and should be very accurate and reliable.

THE "PRACTICAL ENGINEER" POCKET BOOK FOR 1898. Manchester: Technical Publishing Company, Limited. 374 pages, illustrated. Price, 1s. 6d.

The ninth edition of this excellent steam engineer's handbook (compiled annually in the office of the *Practical Engineer*) contains some new matter on the boiler and engine, and in the electrical section. The latter section now comprises 75 pages—mostly matter of direct practical value.

PERSONALS.

MR. MORGAN BROOKS of Minneapolis has been appointed to the professorship of electrical engineering at the University of Nebraska, which is located at Lincoln. This position was vacated by the resignation of Prof. R. B. Owens. Mr. Brooks is well qualified for the work, being a graduate of Brown University and of Stevens Institute. Mr. Brooks is president of the Electrical Engineering Company of Minneapolis, which office he will retain.

MR. F. E. DRAKE has been appointed electrical adviser to Mr. Ferdinand Peck, the Commissioner-General of the United States to the Paris Exposition of 1900. Mr. Drake has had a very extensive experience in electrical matters, and his appointment to this position will be of great advantage to the American exhibitors and to the Commission. He began his connection with electrical interests as a railroad telegraph operator when but 14 years of age. After several years in the operating service, he was transferred to the civil engineering department, and served in several capacities, including that of assistant division engineer. Since 1890 he has been directly connected with the manufacturing industries, having acted as manager of the Standard Electric Company, a concern which played a most important part in the lighting of the World's Columbian Exposition, and in 1896 he formed a partnership with W. D. Ball, of Chicago, under the name of W. D. Ball & Co., electrical and mechanical engineers. This connection he severed in the early part of 1897 to accept the position as assistant to the manager of the Walker Company, where his former varied experience in electrical and mechanical matters has been of great service.

TRADE PUBLICATIONS.

THE BURTON ELECTRIC SMELTING COMPANY, of Boston, Mass., has issued a catalogue which will be of great interest to central station managers. It comprises a complete description of the numerous varieties of forges and smelting machines that it manufactures. The encouragement of the use of electricity for purposes of this nature is a very satisfactory solution of the day load problem in central stations.

"HELPS IN BRAZING."—The Dixon Crucible Company of Jersey City, N. J., has published a little pamphlet with this heading. It especially treats of the process of brazing by the dipping method, or "liquid brazing," as it is called. The brazing crucible is described, together with instruction and caution in regard to its use. Instructions are given how to build and set the necessary furnace, time required for brazing, etc. This pamphlet is of interest to all who do brazing. It is sent free of charge.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, in Circular No. 44, describes the installation of chloride accumulators in the Chicago Edison plant. The battery has a capacity of 22,400 ampere hours, an 8-hour rate, and is able to discharge 11,000 amperes for about 1¼ hours. Central stations are rapidly beginning to realize the fact that the storage battery has been commercial for a considerable period, and is a most valuable auxiliary, both as a regulator and as a means of solving the pertinent day load problem.

THE INTERNATIONAL CORRESPONDENCE SCHOOLS of Scranton, Pa., are mailing a little pamphlet describing their methods of instruction, which are illustrated by practical examples in numerous cases. They bring out the fact that any industrious person who can read and write, can, by careful study, become an electrical engineer, and that correspondence instruction is an immense advantage in his task of securing an education. The fees of the various courses of instruction are given on the last page of the pamphlet. The school has also issued a booklet containing a synopsis of its instruction papers on telephony by Kempster B. Miller, the well-known expert.

THE AMERICAN SCHOOL OF CORRESPONDENCE of Boston, Mass., offers an electrical engineering course, which is carefully supervised by electrical experts, in close touch with the developments in the science. The instruction is graded and thoroughly practical and scientific, and is intended to give to electrical students and engineers a complete training. The students' work is carefully inspected by well known electrical experts. Among the gentlemen connected with the school is Mr. Charles Thorn, chief of the Quadruplex Department of the Western Union Telephone Company. The school is chartered by the Commonwealth of Massachusetts, and is an educational institution, and not a money making enterprise, therefore the tuition fee is placed within the reach of all wage earners. The school has been warmly indorsed by leading educators and engineers throughout the country.

AN INTERESTING ADDITION to Westinghouse trade literature is entitled "Electric Street Railway History," in which the Westinghouse Electric & Manufacturing Company's many types of street railway motor are reviewed and illustrated, beginning with the No. 1 Bipolar type, and coming down to modern practice. Special attention is called to the No. 3 motor, which contains most of the modern features in modern street railway motor practice, viz., single reduction gears, salient four-pole field, slotted drum armature, machine-wound armature coils, insulated before being placed on the core, and the two circuit armature winding. Throughout the book the company frequently calls attention to features which are now modern motor practice, and put themselves on record as adopting them at such early dates that it would be difficult to dispute their prior claim to these improvements. Beside the motor description, which is profusely illustrated by elegant half tones, the subject of generators is taken up, and the Westinghouse engine and belted type machines are illustrated and described. Following the printed matter are views of the Westinghouse works and of large plants that the company has installed. The book is tastefully gotten up, and is interesting reading matter.

BUSINESS NEWS.

"THE SCIENTIFIC MACHINIST" of Cleveland has recently purchased "The Engineer" of New York, a journal seventeen years old whch is devoted to steam engineering. "The Scientific Machinist" and "Engineer" will be combined and published hereafter under the name of the latter.

THE CENTRAL ELECTRIC COMPANY of Chicago states that it is headquarters for all the mica products, including mica, mica segments, micanite segments, micanite cloth, empire cloth and M. I. C. compounds. These goods in all the various forms and types are carried in Chicago stock, and can be supplied immediately.

THE CUTLER-HAMMER MANUFACTURING COMPANY of Chicago reports that its sales for August were larger than any preceding month in the history of the company, which is considered evidence of an increase in the business of the motor manufacturers, to whom most of the company's goods are sold. The company states that it is preparing for a large fall business.

THE WARREN-MEDBERY COMPANY, Sandy Hill, N. Y., manufacturers of inductor alternators, reports a very large increase in sales. They have made recent sales in the following places: Two in Canada, two in New York, one in San Francisco, one in Manitoba, three in Pennsylvania, one in New Jersey, two in New England, three in Texas, one in South Carolina, and one in Tennessee.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, states that in a suit brought against it by the Westinghouse Electric & Manufacturing Company, for infringement of patent, U. S. Judge Clark, of the Southern District of Ohio, rendered a decision in favor of the Triumph Company, and declared void the patent on which the Westinghouse Company based its claims.

THE S. & H. ELECTRICAL COMPANY, of Skaneateles, N. Y., has issued a number of circulars describing its small hand and power dynamos. These machines are simple and low priced. Most of them are intended for experimental work, but the larger sizes are said to be excellent for plating or for running very small electric light plants in machine shops and similar places where power is to be had.

THE LUDEWIG-THURBER MANUFACTURING COMPANY, Pittsburgh, Pa., has removed to more commodious quarters, and has a fully equipped shop and skilled labor for electrical repair work, field and armature winding, refilling of commutators, etc. The company is also conducting a trade in second-hand machinery. Mr. J. Ludewig is the president of the company; Mr. Wm. Ludewig, vice-president; Mr. J. B. McGinley, general manager, and Mr. G. P. Thurber, secretary and treasurer.

NEW ELECTRIC RAILWAY COMPANY INCORPORATED.—The Safety Third Rail Electric Company of New York, capital $1,000,000, has been incorporated to manufacture and deal in electrical appliances and properties of every description in New York City. The directors are Emerson McMillan, Emerson McMillan, Jr., W. F. Douthirt, C. T. Schoville, R. H. Beach, William M. Keepers, David F. Halsted, John McLeod Murphy and Louis Steckler of New York City.

THE OTTO GAS ENGINE WORKS, Philadelphia, report an excellent business among recent large electric light installations. Among these may be mentioned a plant at Stockton, Cal., with two 120-h.p. engines, and one of equal capacity at Sisterville, W. Va. The Danbury & Bethel Gas Company is still using three 100-h.p. Otto engines installed for it over six years ago, and the Otto Gas Engine Works are now erecting a plant in the western part of New York, which will have two 120-h.p. engines and a 60-h.p. engine, the power being used for railway service and street lighting.

EUGENE MUNSELL & COMPANY, of New York and Chicago, importers and wholesale dealers in mica, report a very gratifying demand for their India mica. They carry a large stock at both their warehouses in New York and Chicago, and are, therefore, in a position to execute orders promptly. This concern was one of the pioneers in the preparation of mica for electrical purposes, having sold to the Edison Company at a time when it was engaged in the manufacture of electrical apparatus to such an extent that it required but two armature winders, dating back in the 80's.

THE TRIUMPH ELECTRIC COMPANY of Cincinnati, Ohio, calls attention to the fact that the Giant See-Saw, one of the unique amusement devices at the Omaha Exposition, is operated by a special motor of its construction. This see-saw employs an immense girder pivoted in the center and built entirely of steel. At either end of the girder is carried a car, and as the tower on which it is pivoted is 100 ft. high the maximum elevation of the car is about 200 ft. At night two large Rushmore searchlights, operated on either end of the beam, add greatly to its imposing appearance.

THE K. & W. COMPANY, of Pittsfield, Mass., reports a fine trade in its supplies, consisting of the Hardy Incandescent Lamp, K. & W. dynamo brushes, hangerboards, spark arresters, and commutator compound. This compound is said to be more cleanly to handle and easier to apply than any other form of lubricant, and the repeated orders the company has received for it demonstrate that the claim that it prevents sparking and cutting is well founded. The company also states that the Hardy Incandescent Lamp is finding great favor where high efficiency and sustained candle power are desired.

THE M. C. BULLOCK MANUFACTURING COMPANY of Chicago reports the past month a very busy one. It has received many orders for diamond drill supplies from the North and Northwest, and has also filled a number of orders in entirely new fields. Though foreign orders have been generally withdrawn during the war, it has received from abroad orders for four refrigerator plants, and promise of others, and for two central valve engines for direct coupling to dynamos. The company is preparing its works and force to meet an anticipated heavy demands for the various lines it manufactures.

THE C & C ELECTRIC COMPANY, of New York, wishes to call attention to the fact that it manufactures the form of brush holder known as the reaction type, not as licensees but by proprietary right. It has been inaccurately stated in the technical press that this company has used this holder as licensee, under a patent issued to Mr. R. N. Baylis. The principle involved in the reaction brush holder was discovered and patented by Mr. Baylis, who, however, was at the time chief engineer of the C & C Electric Company, and was materially assisted by that company in making the experiments necessary to the developing and perfecting of the device.

THE ELECTRIC APPLIANCE COMPANY of Chicago has taken the general Western agency of the Utility Shade Company, manufacturers of the Utility shades in paper and celluloid. These shades are something quite new in the electrical line, and are destined to find a very large field, as they possess a great many points of merit, among which may be mentioned the following: They are very light in weight, neat in appearance and practically indestructible. They require no separate shade holder, and are low in price. They are made in a number of different shades and colors. The Electric Appliance Company has issued a special catalogue of these goods, which they will be pleased to send to the trade upon application.

THE ROCKWOOD MANUFACTURING COMPANY, Indianapolis, Ind., reports a constantly increasing demand for its paper pulleys, and is arranging for an increase in factory facilities in order to enable it to keep abreast of its orders. Among other large shipments made recently were 130 pulleys to the Munger Improved Cotton Machine Company, Dallas, Tex.; 74 to the General Electric Company, 17 to the Eddy Electric Manufacturing Company, 14 to the Westinghouse Electric & Manufacturing Company, 9 to the Fort Wayne Electric Corporation, 7 to the Thresher Electric Company, Dayton, Ohio; 11 to the Pueblo Electric Street Railway Company, Pueblo, Col.; 6 to the Commercial Electric Company, Indianapolis, Ind., and innumerable smaller orders for one and two pulleys each.

THE ELECTRICAL TRADE will be interested to learn of the recent arrangements made by the Western Electric Company to exclusively represent the Stanley Electric Manufacturing Company in the following territory: Michigan, Ohio, Kentucky, Tennessee, Alabama, Mississippi, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Missouri, Arkansas, Louisiana, Texas, Indian Territory, Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Montana, Wyoming, Colorado and New Mexico. A complete stock of transformers and other appliances to insure prompt shipment will be carried in Chicago. Correspondence is solicited from intending purchasers of alternating apparatus for any purpose, single phase, polyphase, power transmission, transformers, switchboards, instruments, etc., and all orders and inquiries will have immediate attention.

THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS held its seventeenth annual convention at Pittsburgh, Pa., from Sept. 5 to 10. The Westinghouse Machine Company tendered the association a banquet, which was served in the testing room of its factory. The big assembly hall was cleared of its engines, and a banquet table for over 600 was spread. A tasteful menu was distributed to the guests. Following the banquet were many appropriate toasts, Mr. George H. Brown of the Philadelphia Gas Company acting as toastmaster. Sept. 7 was set aside as Westinghouse day, and the programme which was circulated will convey at once to the non-attendants at the convention an idea of the thoroughness with which the Westinghouse Machine Company undertook the task of entertaining its guests. Such entertainments as these tendered by the large manufacturing firms tend to put the makers and users of the apparatus in closer touch, and to enhance personal regard.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY of Pittsburgh, Pa., has just executed a contract for the Snoqualmie Falls Electric Power Company. The power station is located at Snoqualmie Falls, Washington, forty-five miles from Tacoma and thirty-one miles from Seattle, to which places current is transmitted and then utilized by Westinghouse motors. The contract involves the building and delivery of four three-phase rotary armature generators having an aggregate capacity of 600 k.w., which are to be direct connected to water wheels, and two 75 k.w. kodak exciter dynamos, also to be direct connected to water wheels. In addition the contract called for high and low potential switchboards for the various stations and sub-stations, involving seventy-six marble panels, with all necessary instruments. There will also be installed 10,875 k.w. capacity in high tension oil insulated static transformers, together with rotary transformers of a total output of 2700 k.w. and six type "C" motors developing 1600 h.p. Adequate lightning protection at both ends of the line is provided. The line potential will be 25,000 volts, and the current will be carried over bare aluminum wires to substations, where step down transformers will sufficiently reduce the voltage for safe transmission within the corporate limits of the two cities.

JOHN A. ROEBLING'S SONS COMPANY, of Trenton, N. J., has recently completed a large addition to its electrical wire plant. This firm has been for years a large manufacturer of electric wires of all kinds, and underground and submarine cables, but has not heretofore made its rubber insulating compounds in its own factory, that work having been delegated to the Crescent Company. The addition to the wire plant will enable the Roebling Company to enter this particular field of manufacture and produce a wire that is wholly "Roebling." The insulating plant is contained in a large three-story brick building, about 60 ft. x 160 ft., situated conveniently near the other buildings of the company, which are used for the manufacture of wires. Railway tracks pass immediately in front of the building, affording ample shipping facilities. The equipment consists of the latest and best machinery for the different manipulations of the rubber, and includes appliances for making all varieties of rubber insulation for conductors, including house wires and cables, wires and conductors for street cars, feeders and taps, and heavy lead incased cables for high tension currents. The machinery is mounted on several floors of the building, and ample storage and drying room is provided. Skilled operatives and experienced foremen have been engaged to maintain the high reputation of the Roebling Company. The factory is now in full operation, and prepared to furnish everything in the line of rubber insulated wires or cables.

THE HAZELTON BOILER COMPANY of New York, sole proprietors and manufacturers of the Hazelton or Porcupine Boiler, has orders from the following concerns: 500 h.p. for the Morris County Electric Company, Morristown, N. J.; Brookline Gas Light Company, Boston, Mass., 750 h.p.; American Gas Company, Philadelphia, Pa., 2.0 h.p., for its plant at Port Chester, Westchester County, N. Y., in which there are already three boilers of the same type; Newark Gas Company, Newark, N. J., 300 h.p. (fifth boiler same type); Olcott Falls Company, paper manufacturers, Wilder, Vt., 800 h.p. (third order); Rochester Gas & Electric Company, Rochester, N. Y., 500 h.p. (tenth order), mak-4500 h.p. of these boilers in that very complete plant. The Rochester company has also recently purchased a 500-h.p. boiler from Syracuse, N. Y., Heat & Power Company, which will shortly be moved to Rochester, and erected in its electrical department. The Oakland Gas, Light & Heat Company, Oakland, Cal., has purchased a new steel jacket for a 200-h.p. Hazelton Boiler erected about ten years ago, and now to be equipped with all the latest improvements; Wagner Palace Car Company, Buffalo, N. Y., steel jackets for five 150-h.p. Hazelton Boilers, which were erected in circular brick settings about eight years ago. The Gilbert & Bennett Manufacturing Company, Georgetown, Conn., has purchased steel furnace casings for two 500-h.p. Hazelton Boilers in their western plant at Wireton, Ill.; Messrs. Bartlett, Hayward & Company, engineers and founders, Baltimore, Md., 100 h.p. for a gas works plant at Jamaica, L. I.; Goodyear's India Rubber Glove Manufacturing Company, Naugatuck, Conn., 300 h.p. (third order); South Middlesex Street Railway Company, South Framingham, Mass., 150 h.p. (third order); Messrs. Wm. P. Youngs & Bros., planing mill, New York City, 100 h.p.; and Messrs. Zahn & Bowly, 50 h.p. for their factory at Rutherford, N. J. All of these boilers are to be equipped with the new brick-lined steel jacket, with square furnace and square-grate surface lately introduced by the Hazelton Boiler Company.

CONVENTION NOTES.

THE CENTRAL ELECTRIC COMPANY, of Chicago, was represented by its president, George A. McKinlock.

THE EDDY ELECTRIC MANUFACTURING COMPANY, of Windsor, Conn., was represented by Mr. G. M. Angier.

THE OKONITE COMPANY, LTD., of New York, sent Mr. Romaine Mace to look after its interests at the convention.

THE CENTRAL ELECTRIC COMPANY, of Chicago, was ably represented by its well-known president, Mr. Geo. A. McKinlock.

THE H. B. CAMP COMPANY, Aultman, Ohio, sent Mr. A. L. Daniels to the convention to look after the interests of its well-known conduits.

THE JOHN A. ROEBLING'S SONS COMPANY, of Trenton, N. J., had its interests looked after by Messrs. A. M. Whitaker, G. W. Swan and R. W. Welch.

THE PHILLIPS INSULATED WIRE COMPANY, Pawtucket, R. I.—Mr. Henry C. Adams, Jr., secretary of the company, looked after its interests at the convention.

THE JOHN STEPHENSON COMPANY, LTD., New York, exhibited a model of the car bodies it is supplying to the Metropolitan Street Railway Company, of New York.

THE PARTRIDGE CARBON COMPANY, Sandusky, Ohio.—Mr. James S. Speer, secretary of the company, interested many of the delegates in the merits of the Partridge self-lubricating motor brushes.

THE CHICAGO RHEOSTAT COMPANY, through E. R. Harding, showed one of its motor rheostats, which attracted considerable attention from those convention goers who were also interested in electric lighting.

THE "KERITE" WIRES AND CABLES of W. R. Brixey, New York, had their merits ably expounded to convention delegates by the company's secretary, Mr. Geo. F. Porter, secretary of the National Electric Light Association.

THE GARTON-DANIELS COMPANY, of Keokuk, Ia., showed lightning arresters through its agents, Elmer P. Morris, Pettingell-Andrews Company and the Ohio Brass Company. The secretary of the company, J. V. E. Titus, from the home office, was present.

THE STANDARD PAINT COMPANY, of New York, manufacturers of the well-known P. and B. paint and insulation, distributed at the convention as a souvenir of the occasion a very tasteful pocketbook, which was one of the most popular gifts presented during convention week.

THE JOSEPH DIXON CRUCIBLE COMPANY, of Jersey City, was represented by Messrs. Baird, Haasis and St. John, who distributed souvenir pencils to all visitors, and exhibited samples of Dixon's wood grease for gears, silica graphite paint for trucks, and graphited track grease for curves.

GEORGE A. PARMENTER & COMPANY, of Cambridgeport, Mass., exhibited a fender, wheel guards and track cleaners. The Parmenter feeder is in use in a number of cities throughout the country, and it is stated that not a single serious accident has been caused by cars equipped with this device.

THE CAHALL SALES DEPARTMENT, of Pittsburgh, Pa., exhibited a flowed steel header for boilers and a swinging manhole plate. This company has installed a large number of boilers in electric railway and light stations, and much interest was expressed by the delegates in its exhibit.

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, Philadelphia, was represented at the convention by its president, Mr. H. B. Cutter, who stated that his company had just completed some 4000-ampere double pole circuit breakers for the Western Electric Company, of New York.

THE ELECTRIC STORAGE BATTERY COMPANY was represented in large force, although it made no regular exhibit. Those present in its interests were F. H. Clark, of Chicago; F. J. Stone, of Boston; Charles Blizard, of New York; J. R. Williams, of Philadelphia, and J. L. Woodbridge, of Boston.

THE KEYSTONE ELECTRICAL INSTRUMENT COMPANY, of Philadelphia, had on exhibition a railroad switchboard, including a generator and eight feeder panels, equipped with Keystone instruments. Mr. J. F. Stevens, president of the company, also showed on another board various different styles of his instruments.

THE JANDUS ELECTRIC COMPANY, of Cleveland, with the Creaghead Engineering Company, of Cincinnati, displayed several well-known types of its lamps, including five in series, for street railway circuits, 110 volt, and alternating circuits. The company claims that it has more lamps in use on street railways than any other lamp concern.

THE STERLING SUPPLY & MANUFACTURING COMPANY, of New York, was represented by John H. Carson, president; F. A. Morrell and L. P. Nelson, and its exhibit was largely visited during the progress of the convention. The company has engaged extensively in the manufacture of street railway supplies, and each branch of its business was fully represented.

AMERICAN ELECTRICAL WORKS, Providence, R. I.—Mr. W. J. Watson, the company's New England representative, looked after its interests at the convention. The following officials of the company were also present on various occasions: General Manager Eugene F. Phillips, President Frank N. Phillips, Secretary C. R. Remington, Jr., Treasurer Waggensell, New York Agent P. C. Ackerman, and Chicago Agent Frank E. Donohoe.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., made an extensive display of switchboard instruments for street railway work; also carbon brushes, switches and standard transformers. A number of large photographs were shown illustrating several of the more prominent installations which the Wagner Company has made. E. H. Abadie, manager of sales, of St. Louis, and H. M. Nay, of Boston, represented the company at the convention.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburgh, Pa., had a very pleasant booth where samples of the company's products were exhibited. These included samples of various kinds of cables and insulated wire, rubber, paper and fibre insulated railway feeder cables, aerial weather-proof feeder cables, etc. The interests of the company were cared for by F. A. Rinehart, treasurer; G. L. Wiley, of New York, and T. E. Hughes, of Philadelphia.

ADAM COOK'S SONS, of New York, displayed sample jars filled with Albany grease and Albany electric motor compound. The Albany lubricants are now in use in a large majority of the street railway power stations throughout the country, and have won for themselves an enviable reputation. The electric motor compound especially is giving great satisfaction wherever it is used. Adam Cook and John Engle, of New York, and M. V. Peavey, agent for New England and Canada, were in attendance.

THE CROSBY STEAM GAGE & VALVE Company, of Boston, Mass., had on exhibition a number of Crosby steam indicators, valves, gages, recorders, etc., also a very large three chime steam whistle. The instruments and appliances manufactured by the Crosby Steam Gage & Valve Company are standard in many of the largest power houses in the country, and in workmanship and accuracy they are all that can be desired. This exhibit was in charge of Robert Pirie, Charles M. Gibbs and S. G. Reed.

THE SHAWMUT FUSE WIRE COMPANY, Boston, Mass., had a very complete exhibit of its copper terminal fuses, suitable for railway work, and also showed a new specialty in the shape of an inclosed fuse, the inclosure being a fibre tube, with asbestos ends, an air space in the center, and a magnesia powder packing to absorb the vaporized lead. This fuse was constructed under the Cartwright patents. The company also showed some of its new quick-break switches. The exhibit was under the direction of Mr. H. P. Moore.

THE BILLINGS & SPENCER COMPANY, of Hartford, Conn., exhibited a number of sample boards of commutator segments, also several samples of overhead material. There was also shown what is thought to be one of the smallest and also one of the largest commutator segments ever made. The large segment shown weighed about 25 lbs., and was constructed for a Westinghouse motor at Niagara Falls. Several drop forgings, made of soft steel for Lundell motors, were also exhibited. W. B. Post and H. E. Billings had charge of this exhibit.

L. A. CHASE & COMPANY, of Boston, Mass., selling agents for the Sanford Plush Mills, made an attractive display of different grades and patterns of plush for upholstering car seats, etc. These plushes are in very general use, being employed almost exclusively by the Pullman Palace Car Company and the Wagner Palace Car Company, and other large car manufacturing establishments. A sample of cattle hair carpet for car floors was also shown in connection with this exhibit. The Sanford Mills were represented by Frank B. Hopewell and George Goodall.

ELMER P. MORRIS, of New York, had, as usual, one of the most extensive exhibits. He exhibited Forest City and Harrington rail bonds, for both of which he is agent. Another interesting portion of the exhibit was that devoted to the Sterling Railroad inclosed arc lamps. In the exhibit of the Keystone Electrical Instrument Company, for which Mr. Morris is also agent, a set of switchboard instruments of different types were shown. These were mounted on a model of a railway switchboard, made up of feeder and generator panels, and equipped with the Keystone instruments.

THE ALBERT & J. M. ANDERSON MANUFACTURING COMPANY of Boston, Mass., was represented at the convention by Albert Anderson and C. B. Pear. This company's regular line of overhead material was shown, including the West End type of hangers, insulators, ears, crossovers, etc. A recent addition has been made to the extensive line of Anderson material in the way of an insulated crossing which is made of steel. This device is in use on the lines of the Union Traction Company, of Philadelphia, and is designed to be extremely light. The Albert & J. M. Anderson Company distributed a very serviceable notebook as a souvenir.

THE DEARBORN DRUG & CHEMICAL WORKS, of Chicago, were represented by Robert F. Carr, who gave away some handsome paper cutters, match boxes and some of the neatest advertising pamphlets seen at the Convention. This company is doing a very successful business with the large manufacturing interests and street railways, treating boiler feed waters for scale formation, corrosion, pitting and the general troubles experienced with boilers. Their laboratories in Chicago are the most completely equipped on the continent, and their lubricating oil department has within the past few years grown to very large proportions.

THE GOLD STREET CAR HEATING COMPANY, of New York, had an attractive location in one corner of the building, and made an interesting exhibit of its different types of electric heaters, the basis of which consisted of the Gold improved support. The company showed its three degree panel heater, large and small sizes, and an assortment of Gold standard heaters for cross seat and longitudinal seat cars, also a number of other types and ornamental heaters for room heating purposes. As a souvenir, the company presented a leather-bound memorandum pocketbook. The interests of the company were well cared for by E. E. Gold, John E. Ward, H. E. Beach, E. H. Mossgrove and Fred D. Weston.

THE SAFETY THIRD RAIL ELECTRIC COMPANY, of New York, displayed in a 21 ft. x 39 ft. space, in the lower exhibition room, a complete miniature working model of its system. Current was conveyed to a one-sixth size, completely equipped car operating over about 150 ft. of track, with all sorts of curves and grades, and the working of the miniature system seemed to be in every way successful. The space allotted to the company was almost constantly occupied by interested spectators, among whom railroad men were very much in evidence. The company was represented by John McLeod Murphy, inventor of the system; E. V. Ballard, who built the model road shown, and by Gustavus Kahn, William Devoe and John J. Cokely. It is stated that a controlling interest in the stock of this company has been purchased by Emerson McMillin & Co., of New York, who will soon construct a full working system of several miles in length as a demonstration of its safety and efficiency.

THE PECKHAM TRUCK COMPANY, of New York, had probably the most elaborate exhibit of any company at the convention. It consisted of the entire system of Peckham single and double trucks. Some of the double trucks shown by Mr. Peckham this year were new, and the fact that he is now in a position to supply double trucks for any character of service made the exhibit particularly interesting, and both styles were very carefully examined by the attending managers. Mr. Peckham does not believe that the same truck is suitable for all classes of work, but believes in selecting for use the character of truck best adapted to the service. For this reason he has completed his line of double trucks shown a year ago by several other forms, so that he is now in a position to supply railway managers with a light or heavy truck, a flexible or a swing bolster, a short wheel base or a long wheel base truck, and an ordinary double, or maximum traction, truck. As a souvenir, Mr. Peckham presented delegates with an exceedingly tasteful pocket memorandum and card case in white leather, and no other souvenir was in greater demand. He also presented a series of very tasteful catalogues descriptive of his apparatus.

THE WALKER COMPANY, of Cleveland, made a very complete display of electric railway apparatus. About the only exception to railway apparatus shown was an exhibit of Walker inclosed arc 100-hour lamps. The railway apparatus shown comprised the following: A three-panel four-circuit switchboard of 1200 amp. capacity; a case of armature parts showing details of construction of armatures and commutator; a stand of armatures showing completely and partially wound armatures, armatures with commutator attached, and plain core; two "33-S" railway motors, 20 h.p., one open and one closed, with controller showing solenoid blow-out; two "15-L" railway motors, 75 h. p. each, with "S-11" controllers, solenoid blow-out and double h.p. equipment; underground conduit—a complete equipment for 60 ft. of track shown, with feeder hatch connections and regular Walker construction. Upon the track was mounted a Peckham truck with a pair of "5-L" Walker motors. The company was very well represented, officials and agents being in attendance from New York City, Cleveland, Philadelphia, Baltimore, Pittsburgh, Buffalo and Boston. Among those were Professor Short, H. McL. Harding, C. F. Black, superintendent of the New Haven factory; H. G. Issertel, M. D. Law, F. W. Sawyer, H. B. Gay, R. A. Byrns, J. Holt Gates, A. T. Moore, W. G. Bain, J. N. Dodd and John D. Moore.

THE BIBBER-WHITE COMPANY, of Boston, Mass., had a very popular exhibit located near the center of the hall in a corner space. The two back walls were fitted up with a complete line of samples, representing goods of this company's manufacture, and also "Cutter" circuit breakers, Forest City bonds and segments, New Haven fare registers, Hope double and single pole quick break switches, for which the Bibber-White Company is agent. Line material was shown manufactured in several different patterns. The company is also placing on the market a corrugated steel trolley pole. The souvenir which was given away to the trade was an aluminum pen-holder, which represented the company's seamless cold-drawn corrugated trolley pole. The souvenir was complete with harp and wheel. The latter was of rubber, to be used as an ink eraser. The company also had on exhibition a phonograph machine, which attracted a great deal of attention, and was heard all over the hall. A large illuminated sign over the booth was also attractive. The two side railings to the space were made of cross-arms complete, with braces, pins and glass insulators. On each side of the entrance was an octagonal pole, and on each pole were attached the different styles of bracket arms manufactured by the company. The exhibit was in charge of H. W. Smith, the manager of the company's railway department. He was assisted by Charles E. Bibber, president; E. L. Brown, treasurer; Thomas H. Bibber, general manager; David W. Dunn, Charles F. White and Chauncey Hight.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY furnished one of the most curious and interesting exhibit features which has ever been seen at a convention. The company's space was at the very entrance to the association's meeting room, and attention would first be called to it by a sharp and constantly increasing crackling sound of an odd character. There would then be seen at one side of the exhibit a large board, constructed of thick, heavy glass and bearing on the front, in metal letters, the words, "The Name of Westinghouse is a Guarantee." Those who pushed their investigation far enough found the back of the glass board was covered with large sheets of metal foil. Over in one corner was a rotary converter, which obtained current from the Boston Electric Company's lines at 500 volts direct, and changed it into a 380-volt alternating current, which fed two transformers, whose effect was to still further reduce the voltage from 380 to 200. This 200-volt alternating current thence passed into a high tension transformer, from which a 60,000-volt alternating current issued. The wires from the high tension terminals of this transformer passed one to the metal letters on the board, and the other to the tin foil at the back. On starting the rotary transformer the voltage between the front and back of the glass board would be raised to such a point as to cause "lightning discharges" to pass over the surface of the glass between the letters and the tin foil, and as the voltage was increased these flashes would become almost terrific in their intensity, while the smell of ozone would penetrate to quite a distance from the board. Elsewhere in the Westinghouse Company's exhibition space were found a number of features interesting to railway managers, including a complete set of apparatus for operating power station switchboards by compressed air. There were also exhibited the Westinghouse No. 49 (35-h.p.) railway motor, open, and with a separate armature, the Westinghouse 38 B (50-

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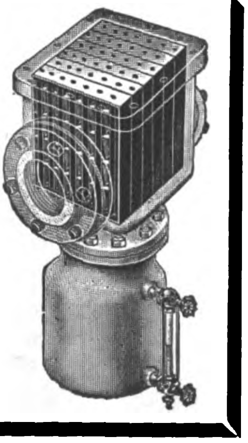

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THE GENERAL ELECTRIC COMPANY did not consider it necessary to make any special exhibit of its apparatus, as all the great dynamos now used to furnish current to drive the street cars of Boston were built in its works; many of the motors were of its manufacture, and, with few exceptions, every switchboard and controller. The company, therefore, decided to show in the convention hall not so much great facilities as the world-wide use of its apparatus. Consequently, a huge globe representing the earth was built up of papier maché upon a framework of wood, and placed at the end of the hall, where nothing intervened between the floor and the roof. This globe rested upon a black pedestal picked out with gold. The continents and oceans were plainly depicted by the scenic artist of the Tremont Theatre. The globe was built in fifty-four distinct sections to a scale of 312 miles to 12 in.; was 25 ft. 2 ins. in diameter, and weighed 3 tons. The pedestal was 16 ft. in diameter, and the globe was placed in exactly the position occupied by the earth itself in the solar system, the north pole being indicated by an incandescent lamp of 100 c.p. Two thousand seven hundred square yards of papier maché, in 9 layers of 300 sq. yds. each were employed in the construction of the globe, the building of which occupied just two months. Dotted over the globe, thickly in the United States, less thickly in Europe, and sparsely in the less civilized countries, were small incandescent lamps of different colors, each lamp representing the location of some city in which the General Electric Company has some typical installation; 400 lamps were employed. Each country was indicated by its national flag, and the Stars and Stripes fluttered not only over the United States, but also over Cuba, Porto Rico and the Sandwich and Philippine Islands. The interior of the globe was richly upholstered, the decorative color scheme being worked out in pink and green. The air was kept cool by revolving electric fans, and the lighting of the interior was all indirect. An aurora borealis effect was secured over the north pole of the globe, both inside and out, by groups of small orange red lamps, and the southern polar light was represented by a row of lamps concealed between the globe and the pedestal. The course of the sun around the globe was marked by a small track occupying the plane of the elliptic, upon which once in a minute traveled a miniature trolley car, labeled "world circuit." The globe will remain in place during the Mechanics' Fair, and will then be taken down and sent to Paris, where it will occupy a prominent position in the Electrical Building at the Exposition of 1900. The space behind the globe was set out with comfortable chairs for the benefit of visitors. Here also was set up a model plant to show the practical working of the Thomson car recording meter, consisting of a G. E. 800 motor, an R-11 controller and the necessary resistances, the car meter, fuse and a form M circuit breaker. Behind this plant was an instrument board on which were exhibited the latest types of astatic volt and ampere meters, inclined coil switchboard and portable instruments, motor vehicle meter, and edgewise ammeter, all grouped around a type M station recording wattmeter reading to 8000 amps. Let into the pedestal of the globe were two spaces fitted with shelves, on which were the most recent types of overhead material, circuit breakers, lightning arresters, etc. The entire convention hall was lighted from G. E. inclosed arc lamps. Headquarters were established in the Hotel Brunswick, where, in the Venetian room, several albums containing photographs showing the wide diversity of General Electric work and a fine collection of medals and diplomas were set on the tables. W. J. Clark, general manager of the railway department, had the interests of the General Electric Company in his care.

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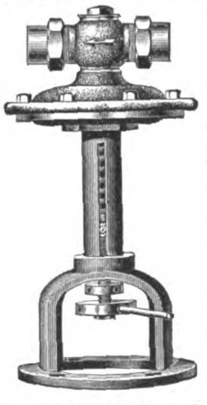

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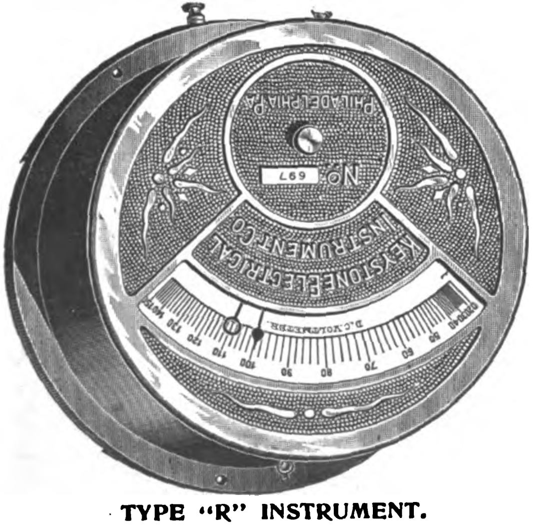

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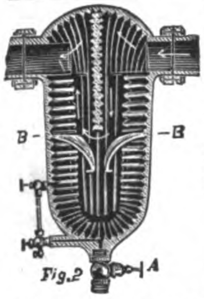

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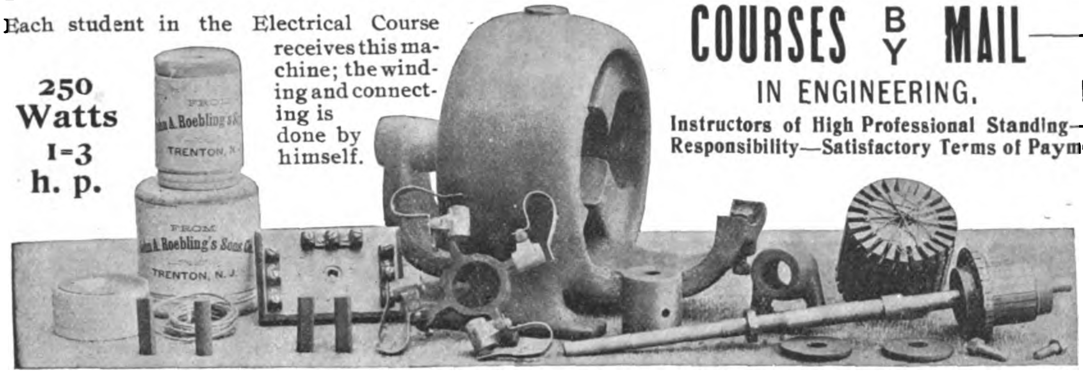

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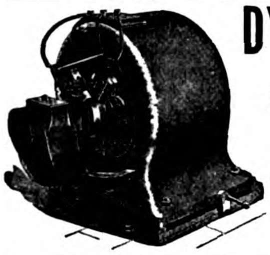

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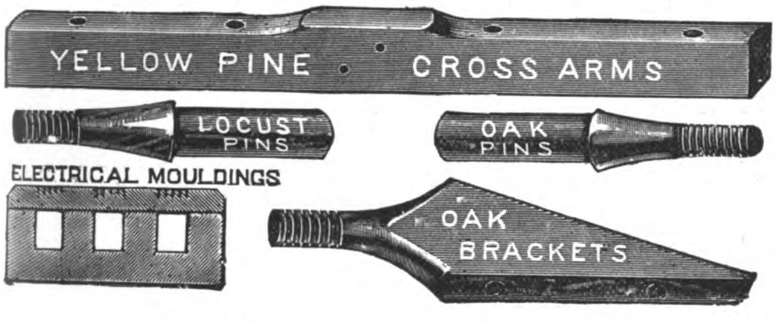

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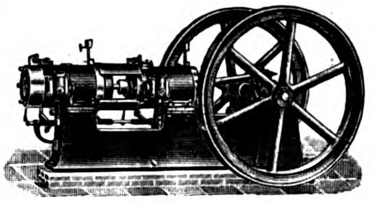

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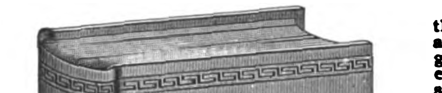

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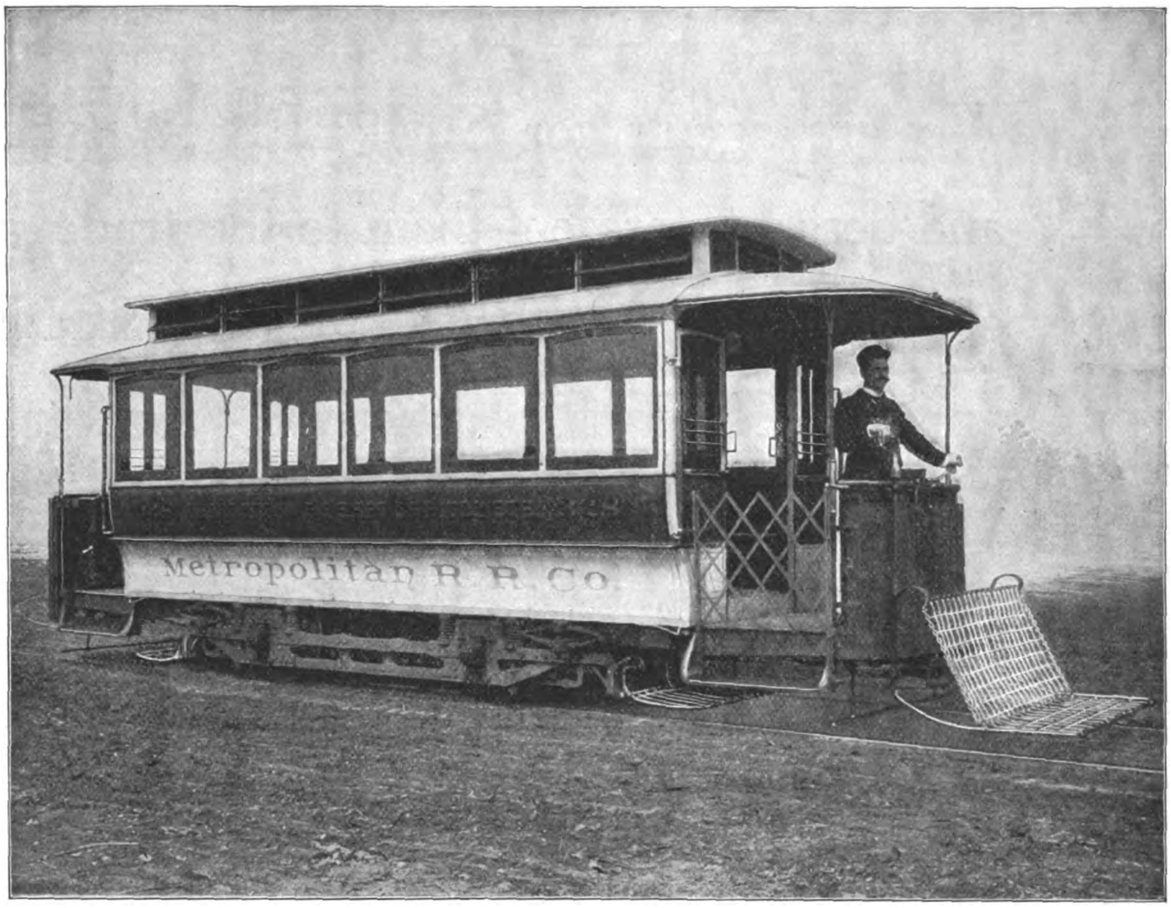

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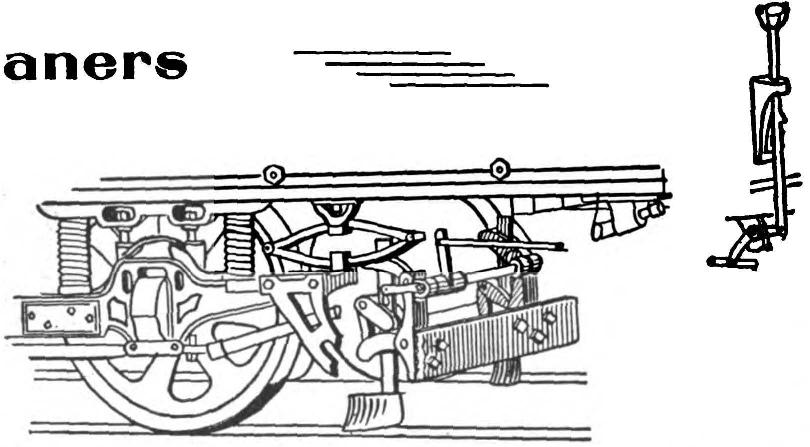

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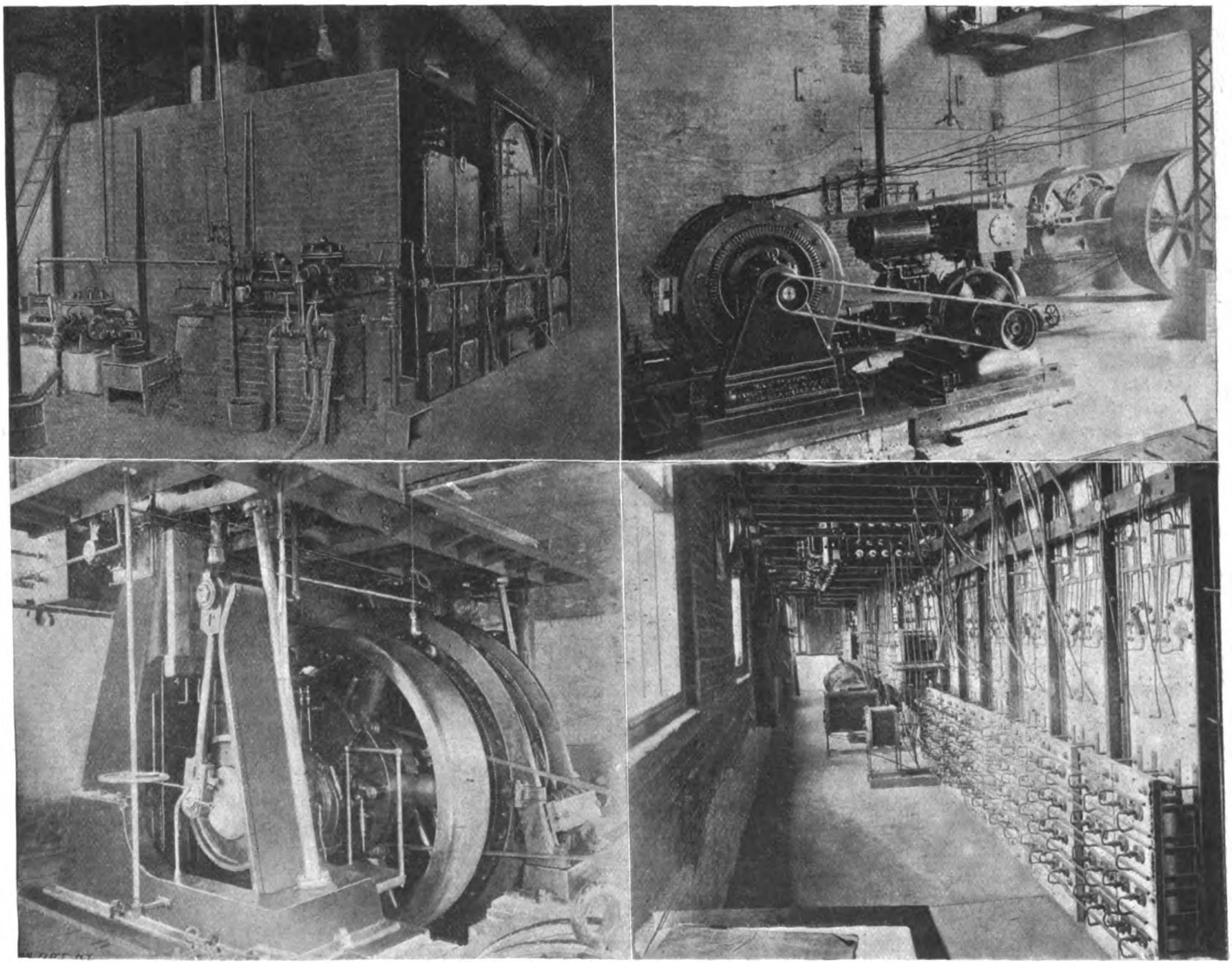
American Electrician.

Vol. X. New York, November, 1898. No. 11.

POLYPHASE PRACTICE IN SMALL STATIONS AT THE PLANT OF THE HACKENSACK GAS AND ELECTRIC COMPANY.

The plant of the Hackensack Gas & Electric Company, Hackensack, N. J., has recently undergone a complete remodeling and is now equipped with the highest grade of modern machinery. It is an excellent example of a small multiphase installation, and a description of its equipment and its service will be of interest to managers of small plants similarly situated.



FIGS. 1, 2, 3 AND 4.

BOILER ROOM.
LARGE GENERATOR.

BELTED GENERATOR.
BACK OF SWITCHBOARD.

The original electric service was remarkable chiefly for its variety. No less than three different currents were supplied for purposes of power and light. The equipment represented the gradual accumulation which a slowly increasing business always begets. There were two 30-k.w. belted General Electric direct-current generators and two 12½-k.w. machines of the same type. These were four pole dynamos and supplied current to points within a short distance of the station. For long distance service two 60-k.w. General Electric alternators operated at 125 cycles per second were used.

An Edison Sperry series arc machine with a capacity of thirty-two 9½ ampere lamps supplied arc lights. This motley collection of machinery was driven by a large countershaft, which in turn was belted to several high speed engines. The use

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of so many small units of such widely diversified types cannot be attributed entirely to the engineering judgment of the former managers of the station, for a few years ago the station was totally destroyed by fire, and the necessity of immediately restoring the service prevented the installation of a plant laid out on the lines of best economy by compelling the erection of one which would soonest be fit for service.

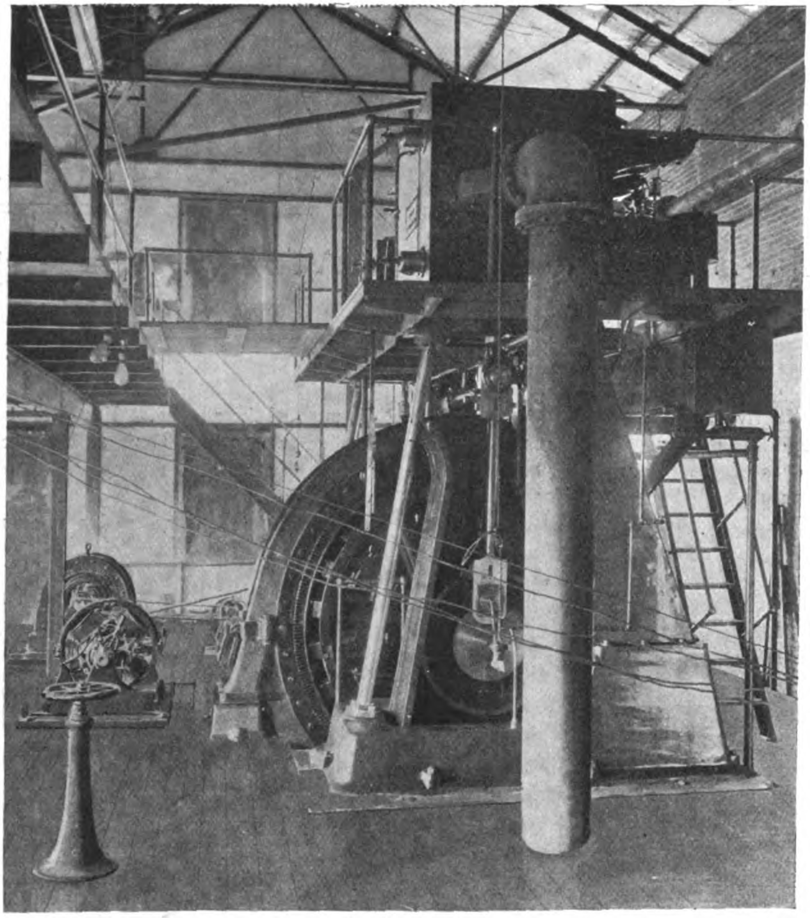


FIG. 5.—GENERAL VIEW OF LARGE UNIT.

It remains to be said that, conditions considered, the machinery was disposed with no little ingenuity in the building and amply fulfilled its object, that of maintaining the service until a modern station could be planned.

The new station service is derived from three generators of the S. K. C. type, this system having been adopted throughout the installation. Two of the generating sets are of moderate size and are intended to carry the day load, while the third is a large direct connected machine and at present can easily carry the entire station load. It is intended that as the plant shall increase the large machine shall be the unit by which the station equipment will be augmented, the smaller machines being intended merely to obviate the necessity of running a large machine lightly loaded.

The boiler room of this plant is adjacent to the main engine room and is fitted with return tubular cylindrical boilers 72 ins. in diameter by 16 ft. long. There are two of these boilers and a smaller boiler, which is presently to be done away with, when three more boilers will be installed, making five in all.

The furnace has a plain cover grate and now burns about 150 tons of buckwheat coal per month, which is fired in a spread fire from 8 to 10 ins. thick. The flue gases escape to a stack 60 ins. in diameter and 70 ft. high. This stack is of steel and is suitably supported by guys.

The station is situated on the shore of a small creek branching from the Hackensack River, which is deep enough to admit a coal barge at high tide. It is intended to erect a coal pocket with a conveyor system on a suitably placed pier, thus greatly decreasing the cost of coal in the boiler room by eliminating the expense of teaming and handling in wheelbarrows. The feed water is drawn from the Hackensack River, and experts have said that it is a fairly good boiler feed water, and that with the assistance of a little carbonate of soda to precipitate the lime salts which it contains, very little scale will be found on the sides of the boiler and that of such a soft and yielding nature that it can be easily removed. The deposit contains salts of lime and iron, and periodically blowing off the boilers and an occasional cleaning is all that is required. The present feeding system is provided for by two pumps, either of which is able to feed the entire battery of boilers. The first of these pumps is of the Worthington make, 6 x 4 x 6. It is supplemented by a Blake pump 7½ x 4½ x 10. The boilers are provided with steam domes, from whence the steam is taken through pipes with long elbows leading to a header. It is believed that these bends are sufficiently long to prevent any trouble that might arise from expansion. The header itself is divided by gate valves.

The steam piping system is constructed with flanged joints exclusively and covered with Monarch pipe covering. In the pipe supplying the large engines is placed De Rycke combined separator and receiver, which is suitably drained. The smaller engines have no separators, but are provided at the throttles with suitable drain cocks, and inasmuch as all the pipes of the engines rise from the upper side of the header there is little danger of the accumulated condensation reaching the engines, provided that the drop to the engine is well blown out before the latter is started.

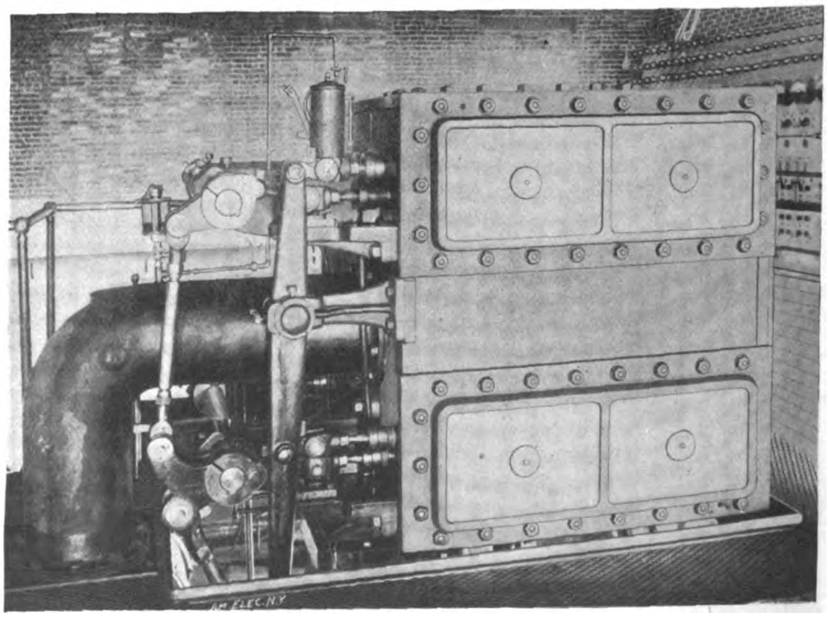


FIG. 6.—VALVE GEAR ON LOW PRESSURE CYLINDER.

The large engine was made by the McIntosh & Seymour Company, of Auburn, N. Y., and is an upright cross-compound with a 24-in. stroke. The high pressure cylinder is 16 ins. in diameter and the low pressure is 32 ins. The speed is 182 revolutions per minute. The high-pressure cylinder is steam jacketed, and a receiver of large capacity is placed between the high and low-pressure cylinders. The high-pressure cylinder has both heads jacketed, as well as the barrel; the low-pressure cylinder is not jacketed, the more efficient device of an intermediate receiver being provided. Fig. 5 displays a general view of this unit to good advantage. Fig. 6 shows a picture of the low-pressure cylinder and gives an idea of the arrangement of the valve gear. There are four valves to each cylinder, and the cut-off valves are worked by a separate eccentric, and both high and low-pressure cylinders are controlled by the governor.

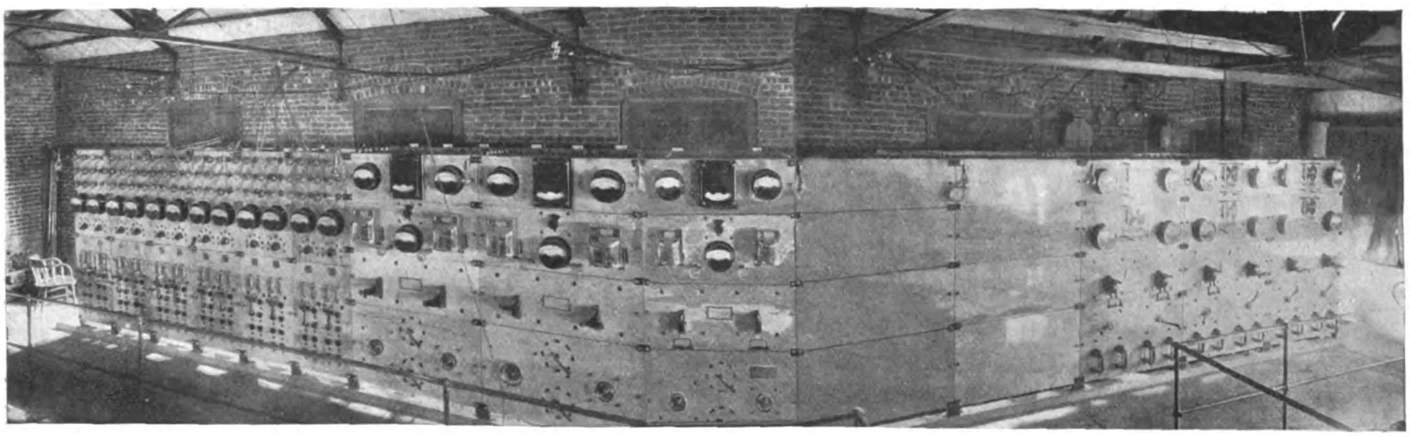


FIG. 7.—SWITCHBOARD.

The governor is of the regular McIntosh & Seymour type.

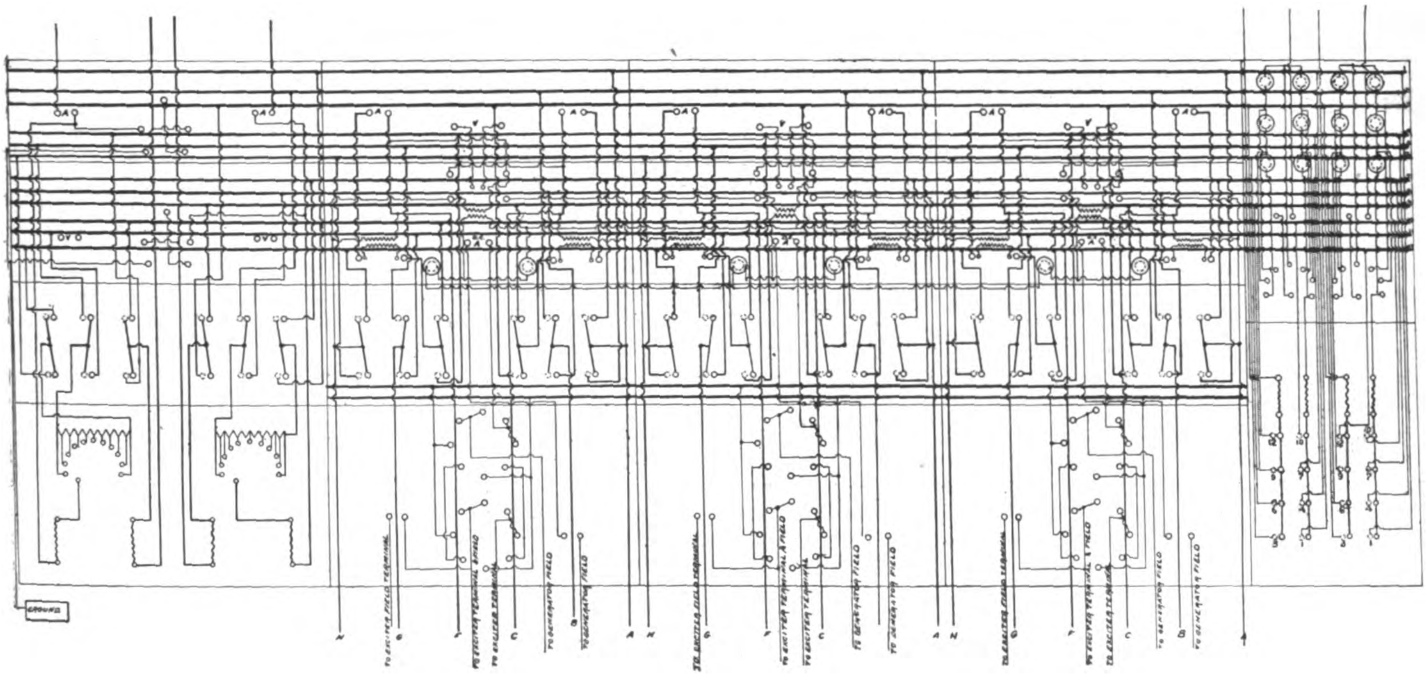


FIG. 8.—SWITCHBOARD CONNECTIONS.

The weight of the engine is 47 tons, of which 19,000 pounds is comprised in the flywheel, and as the inductor of the alternator has considerable flywheel capacity the motion of the engine is very steady. The shaft is 14 ins. in diameter at the armature hub and revolves in journals 11 ins. x 19 ins.

The engine is condensing, the exhaust being discharged into a Blake condenser. It has been found impossible to free the condenser water from oil sufficiently to permit of its use as a feed water, and hence the condenser water is discharged into the creek.

Before entering the condenser the steam passes through a feed water heater of the Wainwright type. The capacity of both the condenser and heater is 600 h.p. The heater, of course, has a certain condensing effect on the steam, and together with the condenser there is no difficulty in obtaining 24 ins. of vacuum continuously.

The smaller engines are those which were retained from the old station. One of these is a McIntosh & Seymour tandem compound running at 250 revolutions per minute. The cylinder dimensions are 13 x 19 x 15. The other is a little Ames engine, 11 x 10, operating at 320 revolutions per minute. Each of these is belted to a small S. K. C. generator.

The large generator is a beautiful piece of machinery. The rotating part has twenty-two poles on each half and is divided into four sections, any one of which can be removed in order to render the armature accessible. The halves of the inductor are secured to the shaft by means of stout bolts and keys. The generator can deliver its output, 350 k.w., in two-phase currents at a voltage of 2500 or 5000, according to the method of connection.

The smaller machines, which are shown in Figs. 3 and 4, are 150 and 50 k.w., respectively. At present the little 50-k.w. machine is sufficient for the day load. The 150-k.w. machine can deliver its output at 2500 or 5000 volts, but the 50-k.w. machine is only able to deliver current at the lesser of these voltages. All of the machines have the same frequency, 8000 cycles per minute, and can operate and be connected in multiple at the switchboard.

An interesting feature of this station is the exciters, and it is necessary to call attention to the fact that they are much too large for the work they are now doing, in order to dispel the idea that the alternators require any such current as the exciters are capable of delivering.

The exciting machines were in fact the two 12½-k.w. machines of the old station. The speed of these dynamos was reduced one-half, which proportionately diminished their voltage, and the field excitation was maintained the same as before by the simple device of connecting the four field coils two in multiple.

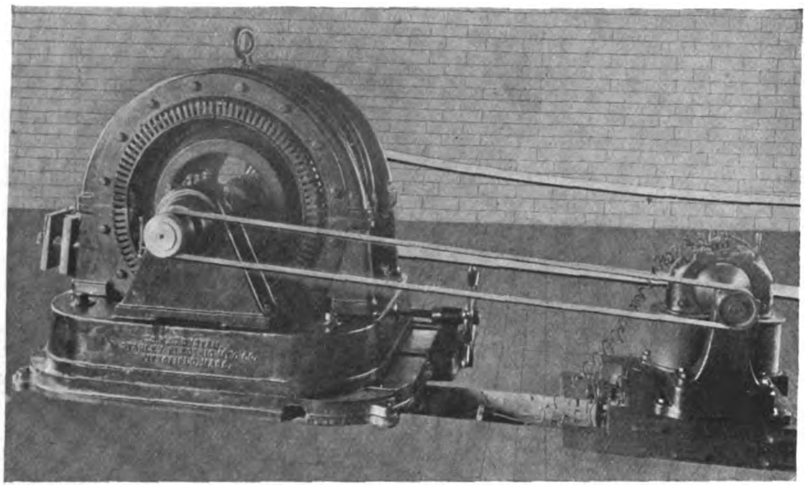


FIG. 9.—50-K.W. ALTERNATOR.

The switchboard is the subject of Fig. 7. This is installed on a balcony, and a bridge is provided connecting the balcony of the switchboard and that surrounding the cylinders of the large engine. The switchboard itself is a handsome construction of marble.

A word of explanation with regard to the illustration is necessary. The switchboard is a continuous construction, the panels being arranged in a straight line. It was, however, impossible to photograph it in one piece, and there was but one station from which it could be photographed, namely, the top of the engine cylinder, and therefore the pictures of the various parts are in three perspectives, and when matched together give the board the appearance of being bent around a corner.

It consists of generator panels, feeder panels and street lighting panels. The generator panels are provided each with a static voltmeter and with a suitable alternate current ammeter for each of the two phases. By means of suitable switches the machines are connected to separate bus bars, but may be connected to a common bus bar if necessary or desirable. A suitable transformer and synchronizing lamp is provided for switching the machine in multiple. Two panels in the middle of the switchboard are left blank, and are intended in the future to be equipped for the control of additional generators.

The service is divided into what is known as the commercial service and the street lighting service. The commercial service consists of a system of feeders, the voltage of each of which is independently controllable by means of a phase regulator. This consists, simply of a transformer with an adjustable secondary, manipulated by a handle on the front of the switchboard. Each circuit is provided with an ammeter on each phase and a static ground detector. The ammeters on this board were made by the Whitney Electrical Instrument Company, of Penacook, N. H., while the rest of the apparatus was made by the Stanley Electric Company, of Pittsfield, Pa. The switches are double throw devices and are manipulated by a rack rod, which meshes to a pinion, to which is fastened the operating handle. The jaws and contacts are on the back of the board. This prevents the possibility of a shock to the operator. The street lighting is on the series incandescent system, forty-eight lamps being placed on a single circuit. These circuits are used to balance the load on the two phases and are therefore adapted so that any circuit can be shifted on any phase of any dynamo. This arrangement is better understood by consulting the switch diagram shown in Fig. 8.

The street circuit is led to a suitable pair of copper bars, which are arranged in a vertical position and carry at intervals suitable contact sockets through which a rod may be thrust, and by engaging with a similar socket placed on a marble slab a few inches back of the main panel it will thus be connected to the bus bars. Two such rods are mounted in a hard rubber crosspiece carried on the end of an insulated handle, and one portion forces both rods in place and connects the circuit to the machine. This pair of rods may be inserted in any one of these plug holes, and as each street circuit is thus provided the load can be balanced very accurately.

The new system, with its higher voltage, is distributed over wires with a triple braid weatherproof covering mounted on deep groove double petticoat glass insulators. It is interesting to note that the old distributing system was bare copper, and that the copper displaced to make room for the new lines was sufficient to pay for the new distributing system with something to spare, and moreover the new system has a line loss of but 4 per cent, whereas the old system had a loss of 11 per cent. This plant supplies the street and house lighting of the following towns: Hackensack, Teaneck, Leonia, Ridgefield Park, Maywood, Arcola, River Edge, Oradell and New Milford, and further supplies current to the Englewood Lighting Company. This latter line is the longest circuit, being fully six miles in length. The eastern circuits proceed directly from the station and cross the river, which is a short distance away, by means of submarine cables. A cable house is to be installed with two or three extra cables, which can be brought into play in case one of the active cables should become disabled.

The motor service is at present very small, consisting of only ten motors. These are the two-phase Westinghouse type, and are used in small stores about the town which need power. There are also fifteen alternate current arc lamps. Arrangements are now being made, however, to increase the power demand and thereby provide a substantial day load for the station.

POSSIBILITIES IN ELECTROMAGNETS.

Electrical artisans and designers have for the most part been familiar with the performance of electromagnets on battery circuits. The application of the electromagnet on a large scale for heavy duty seems to be very limited. The power of a large electromagnet excited by suitable currents, which are now available almost anywhere in industrial localities, is very great indeed and very efficiently obtained. Electromagnets have been used to great advantage for handling steel beams and masses of iron in lieu of ropes and chains, but no one seems to have thought of applying the electromagnet to submarine hoisting, where the difficulty of applying ropes and chains is often very great.

Direct-connected motor driven machine tools are now conceded to be among the highest developments of the art, but there are many cases where rotary motion is transformed very expensively into reciprocating motion, and may be better accomplished by the simple application of an electromagnet. The trip and drop hammers used in our machine shops, and the punching press, offer excellent examples where the electromagnet might be profitably introduced, diminishing the first cost of installation without loss of efficiency. Mining stamps also represent a class of machinery which could be operated by large electromagnets at small expense.

The most popular objection to the magnet seems to be its lack of range. This can be largely overcome. There are plenty of mechanical devices that can transform a short pull of immense power into a moderate pull of longer range. The simple hydraulic device of different size pistons in the same connecting vessel suggests itself in this connection as being one very easy of application by the use of properly designed solenoids. Modern engineering finds no difficulty in constructing iron-clad electromagnets which are applicable to the severest service and will work in localities where a motor will fail utterly. Even if efficiency be somewhat lacking, simplicity will often be an advantage which will more than counterbalance.

For application to rapidly reciprocating tools, such as drills, cold chisels, beading machines and similar devices, there is a large field for the electromagnet. In such cases as these the difficulties have inhered in breaking devices and the elimination of the inductive arcs which occurred there, but this can now be overcome.

Electrical Equipment of the U. S. Cruiser "Newark."

BY E. W. COUNTISS.

The "Newark," one of the first of the famous White Squadron, has been recently overhauled and remodeled, and among the new fittings the electric plant is interesting, and this article is devoted to its description.

The electrical generating machinery consists of three direct-coupled sets. The prime movers are Armington & Sims two-cylinder engines of the inverted vertical type. The cylinders are 7 ins. in diameter, the stroke is 5 ins., and the speed is 400 r.p.m. The cranks are set at 180 degs. The governor is of the centrifugal type and placed on the end of the shaft, outside of the engine bed. The variation of cut-off is transmitted to the two valves—one for each cylinder—by means of a rocker arm and rods attached to the eccentrics. The steam chest and valves are placed between the cylinders. The connecting rods are fitted at each end to the crossheads and crank pins by straps, gibs and keys. The crank brasses are babbitted, while those for the crosshead pins are of gun metal without babbitt.

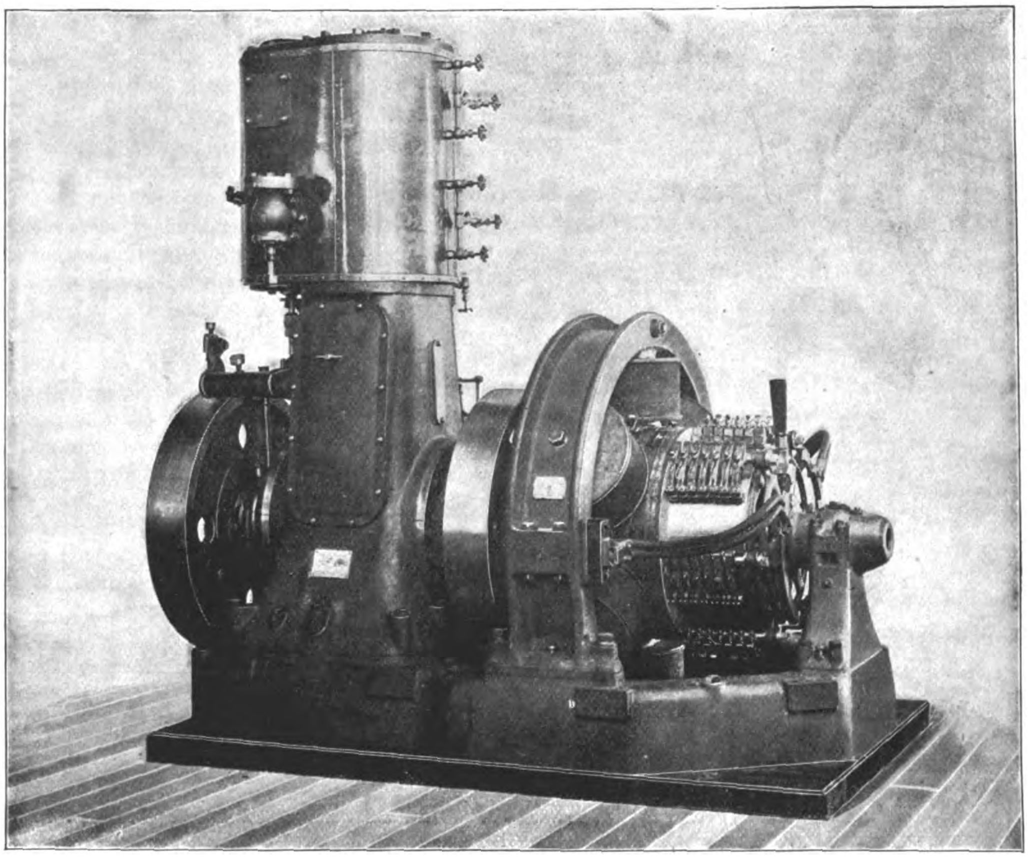


FIG. 1.—NEW GENERATING SET ON THE "NEWARK."

The steam piping is so arranged that the engines can be supplied from either the main or auxiliary boilers, while the exhaust can be turned into the main or auxiliary condensers, or both, and also into the atmosphere.

The steam pressure is adjusted to 80 lbs. by means of a reducing valve in the dynamo room. The pipe line also carries separators drained by steam traps. All drainage is trapped into the hot well.

To these engines are bolted the generators by means of solid couplings. They are three in number, made by the Thomson-Houston Co., of Lynn, Mass. They have four poles, are compound-wound, with cross-connected armatures, and are provided with two sets of brushes. The field frames are made up of Norway iron bars 4 ins. x 1 in., bolted together with cast iron pole pieces, six of these bars composing each field. The series coils consist of twelve turns of wire .128 in. in diameter, having a total resistance of .004 ohm.

Each shunt spool is wound with 800 turns of No. 10 B. & S. wire, having a total resistance when cold of 10 ohms.

The armatures are of the Paccanotti-Gramme ring type, each segment consisting of four turns of flat wire .125 in. x .320 in.

The commutators have seventy-two bars, each being 6⅜ ins. long, 1⅜ ins. deep, and 13-32 in. wide at the periphery. The armatures are 19¾ ins. in diameter; the air gap is 27-64 in.

This formed the original lighting plant; but owing to the installation of electric motors for ammunition hoists the plant was further increased by the addition of a 300-ampere generating set, made by the General Electric Company, of Schenectady, N. Y.

The engine of this latter set is an upright tandem compound, making 400 r.p.m. The cylinders, steam chests and housings are cast in one piece, the cylinders and crosshead guides being bored with one chucking. The stroke is 6 ins. Large bearing surfaces are one of the features of this engine. The bearings are cast iron with babbitted linings and oil grooves. The steam chest is so arranged that the steam pipe can be fitted to either side, as may be most convenient.

In each side of the housings there is a bonnet which can be removed for inspections and repairs to crank and crosshead bearings.

Instead of the usual individual oil cup for each bearing a large tank, holding about 5 gallons of oil, is placed overhead, and a ½-in. brass pipe led to the engine, where it connects to a distributer. Each bearing has its own oil pipe and by means of pet cocks the oil can be regulated to suit the requirements. The governor has few parts, but one weight and one spring, by which the throw of the eccentric is communicated to valves by means of a rocker arm. By adjusting the pivotal point and altering the tension of the spring a cut-off varying from 0 to ¾ can be obtained.

The dynamo is a six-pole compound-wound machine, with the field frame parted horizontally, so that the top half can be readily lifted off. Across the series winding a German silver shunt is placed for regulation, which is very close—within one-half volt from full load to no load.

There are six sets of carbon brushes, six brushes to a set, secured to an adjustable rocker arm.

The armature is an iron-clad drum, with formed coils, and has a massive commutator. The bearing shell at the commutator end is hollow and forms an oil reservoir, into which the oil ring dips. The journal proper runs in an iron sleeve with babbitted lining, such as is used on all General Electric generators.

The switchboard is of the standard U. S. Navy type for three generators. All four of the generating sets are connected to it in such a manner that any circuit can be used on any generator or any combination of them running in parallel. To accomplish this generators Nos. 1 and 3 were connected to the negative bar of the switchboard marked No. 1. The positive leg of No. 1 and No. 3 were each run through an ammeter on the switchboard and then connected together to No. 1 positive bus bar of the board. The equalizing leads from No. 1 and No. 3 were connected to the No. 1 equalizing switch. The positive and negative leads of No. 3 and No. 4 generators were then connected to No. 2 and No. 3 bars respectively, and the equalizing leads to their respective switch terminals. Switches were located between the generators and switchboards so that they could be cut out when not in use.

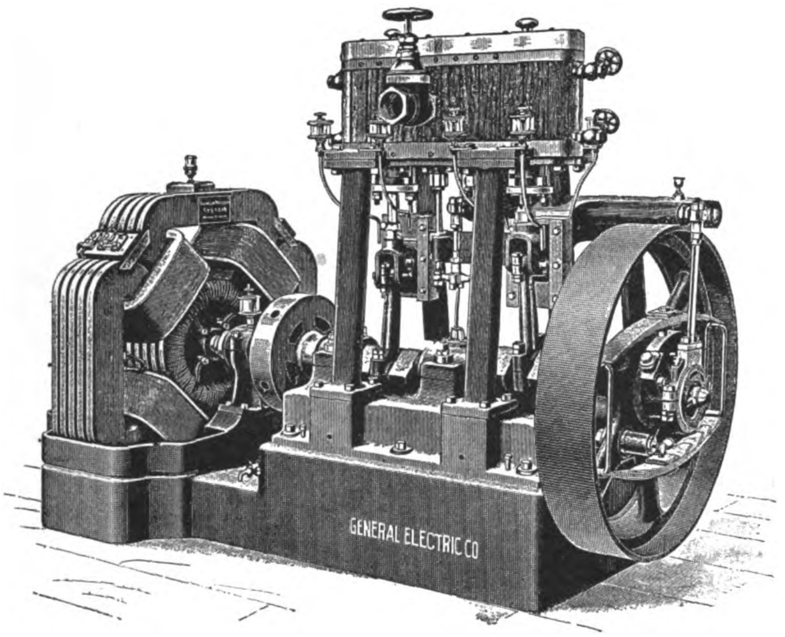


FIG. 2.—ONE OF THE OLD SETS.

Three voltmeters were used. No. 1 voltmeter was connected to generators No. 1 and No. 3 by means of double-pole double-throw knife switches, so that readings could be taken of each. No. 2 voltmeter was connected to generators No. 2 and No. 4 by the same means. No. 3 voltmeter was connected to each of the four searchlights by a single-throw four-point switch, so that the reading of the e.m.f. of the separate searchlights could be taken in the dynamo room.

The ammeters are of the Weston shunt type in metal cases and read to 400 amperes. The voltmeters are of the same make and read up to 125 volts. In the officers' quarters and where water-tight casing was not absolutely necessary the old moulding was replaced with new. But in the fire rooms, over the crank and crossheads in the engine rooms, in the coal bunkers, on the bridges, and spar deck, iron armored conduit was used, with special junction boxes inclosing the regular junction box fittings. Conduit was also used to carry the wires up the masts for the top and mast head lights, and for the guns in the fighting tops, as well as for the truck lights.

Standard fixtures were used throughout the ship. The old style of water-tight junction boxes were converted into the modern style by fitting them with new interiors and screw caps. All the old receptacles were discarded and modern appliances used in their places. Brackets for battle lanterns with hooks to hang the portables on were installed near the breech of each gun and elsewhere where needed, with the plug inserted in the receptacle ready to turn on the switch. Hooks were screwed in place upon which to hang portables. Racks were provided for lamps, both 16 and 32 c.p.

To expedite the handling of the ammunition for the 6-in. guns, which compose the main battery of the ship, the magazines and shell rooms were rearranged. To further add to the efficiency in this direction, electric motors were installed to hoist the shells to the gun deck. A vertical shaft of ½-in. steel plates was built for each magazine and shell room, with a partition which divided it into two compartments. At the top and bottom are shafts upon which are mounted sprockets over which endless chains are carried. To these chains are fastened carriers. Upon these the ammunition was placed and sent up to the guns. The bottom shaft was extended, and keyed to it was a gear wheel, which meshed into the gear wheel on the shaft of the motor. These motors, made by the General Electric Company, of Schenectady, N. Y., are iron-clad, shunt-wound machines, taking 35 amperes at 80 volts. They were connected to a starting panel, see Fig. 9, of polished black slate, located close to the motors, so that the attendant could control both the brake and the starting levers and switches. Brass armored conduit was used in the passing room to incase the wires, and brass junction boxes inserted in the mains to tap off to each panel. The mains are connected to the double-pole switch at the top left-hand corner of the panel. Through this switch current was carried to the fields. The switch at the top right-hand corner is for reversing. By properly connecting the armature leads the direction of the throw of the switch will control the direction of the hoist; that is, if the switch is thrown up the ammunition is hoisted, if downward, the ammunition is lowered. The small switch C is for speed regulation and D is the starting rheostat. E and F are electro-magnetic cutouts, which act in case of excessive flow of current. The motors are of 6 h.p.

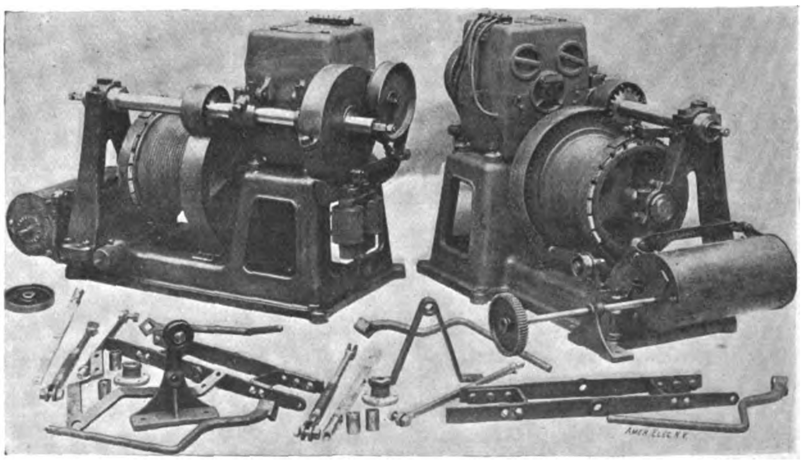


FIG. 3.—VIEWS OF THE AMMUNITION HOISTS.

The searchlights, four in number, are of the 24-in. inclined lamp type, having both hand and automatic feed. The upper or positive carbon is 1 in. x 12 ins., cored, and the lower or negative one ¾ in. x 7 ins., solid. These lamps were so well adjusted that there was no perceptible fluctuation of light during a four hours' run. The mirrors were of the Mangin type, 24 ins. in diameter, 1¾ ins. thick on the edge and ⅛ in. at the center. In the center of the mirror the amalgam was removed, leaving the clear glass for a peep hole, so that the position of the carbons could be seen. To protect the eyes from injury four colored glasses, two red and two blue, were placed in line with the peep hole, reducing the intensity of the ray. By means of hand wheels and beveled gearing the lamp could be focused from the side and back of the drum by altering the distance between the arc and the mirror. The front glass doors are made up of polished plain glass strips ¼ in. x 2 ins., set in a circular metal frame, with the edges ground true. A dispersing lens is provided, which is fitted over the plain front door to extend the beam laterally. This is composed of alternate plano-concave and plano-convex strips of glass fitted into a metal ring, the whole hung over the projecting lugs on the front of the projector drum.

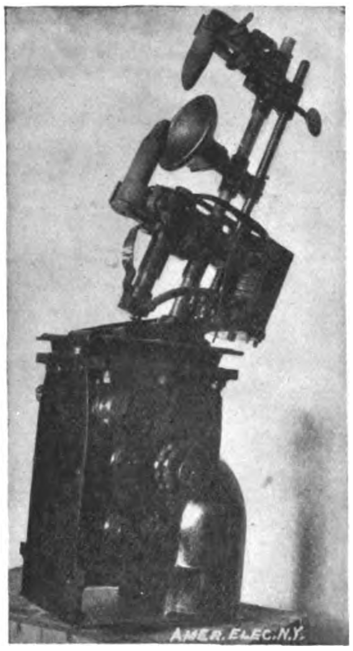


FIG. 4.—SEARCHLIGHT MECHANISM.

The drum is mounted and swung by trunnions on a fork secured to a pivoted base, to allow for directing the beam in any desired direction. On the bottom of the fork the wires are connected to spring plunger contacts through insulating stuffing tubes, with two rings secured to the pedestal. The leads from the switchboard connect to these rings. By this arrangement there is no fouling of the conductors and it gives perfect liberty of motion. The c.p. of each light is about 25,000. An adjustable resistance of German silver ribbon is inserted in the positive lead just after it leaves the switchboard. To get the best light this resistance is set so that the lamp burns at 45 volts and consumes 55 amperes at the lamp terminals.

The Ardois signal set is suspended from a gaff under the truck on the foretopmast. The cable and jackstays are then secured to eyebolts on the rail, and set up taut by turnbuckles. Every 4 ft. the cable and one jackstay are lashed to the topgallant backstay, to prevent swaying in a seaway or storm. These were illustrated in an article in the June number. The keyboard is situated on top of the chart house, so that the operator has an almost unobstructed view all around. The wires leading to the keyboard are led from the signal circuit in the chart house.

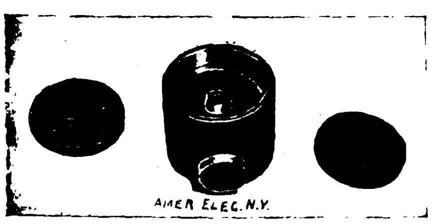


FIG. 5.—THERMOSTAT.

The truck lights are of about the same size and design as the Ardois lanterns, with the addition of a screw base, which fits into a metal cap. This cap is fitted over the topmast head and secured by through bolts. The lanterns have the upper lens red and the lower one white, each supplied with a 32-c.p. lamp. Short lengths of double conductor hemp portable wire are led from each half of the lantern to a receptacle situated in the top, into which is inserted a water-tight plug. Wires are carried up the masts in conduits to these receptacles from the bridge forward, where the pulsating switches are located. These switches are brass cases with outside levers, whereby the red or white half of the lantern can be burned at will. There is also a push button switch by which the lights can be pulsated as occasion requires for signaling purposes. These lights are situated on the fore and mainmasts, each mast having its own light and pulsating switch. Currents for these lights are also taken from the signal circuit.

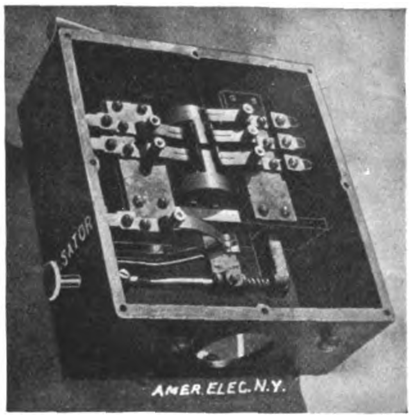


FIG. 6.—SIGNAL SWITCH FOR TRUCK LIGHTS.

An electric lighted binnacle is installed in the pilot house. The wires are carried up inside the base to two contact rings, upon which the top is secured. Plungers on the binnacle cover make contact with these rings, and current is conveyed to a miniature incandescent 80-volt lamp, obscured, except on the extreme bottom, to prevent the light from blinding the helmsman. A cage to protect and a switch to control the light are also provided.

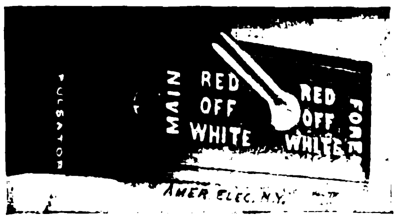


FIG. 8.—BOX FOR SIGNAL SWITCH.

An electric whistle operator, manufactured by the Signal & Control Company, of New York, was installed with the clock mechanism secured in the pilot house, with the necessary "at will" and "automatic" contact switches placed on the bridge.

Racks for holding the battle lanterns were placed at each gun and in the conning tower, upon which the lanterns are placed and the portable wire coiled up, with the plug inserted in its receptacle, so that if light is needed it is necessary only to turn on the switch, thus being always ready.

The bell and interior communicating systems are very complete, providing communication from the captain's and admiral's cabins, ward room, junior officers, warrant officers, to the various parts of the ship. There is, further, a speaking tube system and complete fire and water alarms. The batteries for the first five systems are placed in the pantries, while for the others they were placed in a large locker in the dynamo room. These batteries were of the Leclanche-Gonda type, placed in trays, with divisions between each cell, thus avoiding danger of breakage.

In the captain's and admiral's quarters are installed calls to the pantry and orderlies, from the cabin, staterooms, bath room and office. The wardroom calls are from the staterooms, bath room, lavatory, shower bath and mess tables. The executive officer has calls in addition to the yeoman, master-at-arms and ship's writer; the navigator to the dynamo room; the surgeon to the dispensary; the paymaster to the pay office; the chief engineer to the port and starboard engine rooms, and the engineer's yeoman.

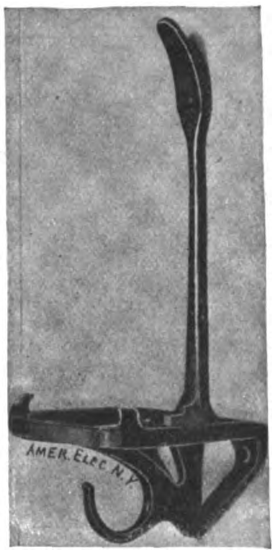


FIG. 7.—RACK FOR BATTLE LATTERN.

The voice tube system is the most extensive and embraces the calls and returns from the conning tower to the engine rooms—starboard and port—steering engine, powder division, central station and dynamo room, etc. The engine room communicates in this way to the chief engineer, fire rooms, dynamo room and steering engine, besides a multitude of calls to every part of the ship. In exposed places water-tight bells, buttons and annunciators are used. Where main trunk lines branch brass connection boxes are used, the wire made fast to terminals in metal boxes of various capacities.

Where joints are made a rosin core solder is used, as acids and salts are prohibited.

The general alarm gongs are seven in number, divided so as to reach the greatest area of space, so that everyone will be informed of the call. They are 12 ins. in diameter, single-stroke, mounted on a polished mahogany base, the whole secured to the bulkheads or other such support.

The contact maker is an inclosed water-tight brass case, by which these alarm gongs are made to strike.

The fire alarm system is composed of inclosed mercurial thermostats, secured to a hard rubber base and then screwed into a metal case with perforated lids, which allows the heat to reach the mercury and at the same time protects it from injury from lumps of coal. There are fifty-seven of these thermostats in the coal bunkers and store rooms.

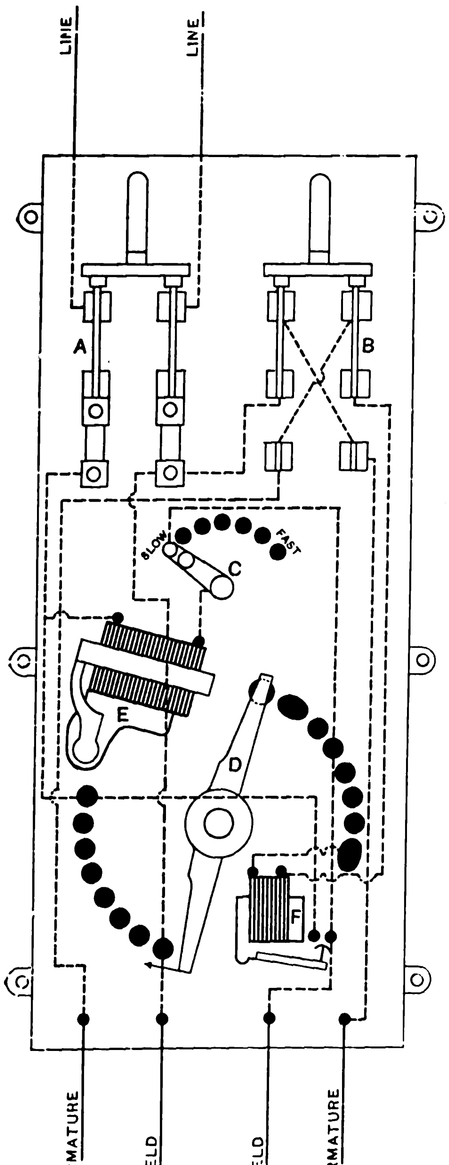


FIG. 9.—SWITCHBOARD FOR AMMUNITION HOIST.

The water alarms are six in number, placed forward and aft about 6 ins. from the outer sheathing, with double bottom.

These fire and water alarms lead to the same annunciator and are fed from the same battery, the annunciator being placed in the cabin constantly under the eye of the captain's orderly. Each drop has its own individual switch, so that in case of accidental short circuit on that line it can be cut out without interfering with the rest of the system.

In addition to the batteries a rotary transformer is supplied and placed on top of the battery locker to furnish current for the fire and water alarms, general alarm and voice tube systems. By means of double-pole double-throw switches it takes but an instant to change from one source of current to another. The transformer at the primary end receives current from the electric light mains at 80 volts, and delivers 20 volts at the other end. The type used is made by the Crocker-Wheeler Company.

Test of a Multi-Circuit Direct-Current Dynamo.

BY EDWARD J. MURPHY, JR., AND P. EDWIN VAN SAUN.

The demand for a direct-current dynamo capable of supplying to two or more circuits current at different voltages that are independent of each other is well appreciated. Such a machine offers the advantages that can be derived from two or more separate machines without the additional first cost expense för maintenance and floor space. The Rushmore multi-circuit direct-current dynamo is at present the only representative of this type of machine, and it is believed that the following article, which is descriptive of a test on one of these machines, will be of interest, as it contains information regarding what may be expected from this type of dynamo.

The manifold uses to which a machine of this character might be put are well known. It may, for example, supply current differing in voltage to the feeders of an incandescent lighting system, or it may furnish current at a given voltage to a lighting circuit on one side, while from the other current at a different voltage for charging storage batteries might be drawn. As a transformer for direct currents it opens up a new and interesting field for experiment. In this application current would be supplied to the circuit on one side, serving to drive the armature as a direct-current motor, and from the circuit on the opposite side current would be drawn at a voltage differing from that of the supply, and limited only by the speed and capacity of the machine.

In the design and arrangement of the mechanical features of the machine which formed the subject of this test the plan followed is similar to that pursued in the case of an ordinary multipolar single-circuit direct-current dynamo. The machine has four poles, each being provided with "form wound" field coils, each pair of which was connected as a shunt to the pair of leads from the brushes collecting the current between the corresponding poles.

The armature is of the drum four-path lap-wound type, but a Gramme ring winding might be substituted without interfering with the action of multi-circuit working. The current is drawn from the armature by four sets of brushes, placed so as to commutate between each pair of poles. Current for one circuit is taken from the right-hand side, while the remaining two brushes furnish a source of supply for the other circuit. Fig. 1 will assist in understanding these electrical connections.

In the ordinary multipolar dynamo the assumption has always been held to be correct that if two adjacent poles be excited to an equal strength the magnetic flux will tend to divide equally, producing a uniform magnetic field, which, acting on an armature of the drum or ring type, will produce an equal difference of potential between each pair of brushes of opposite sign.

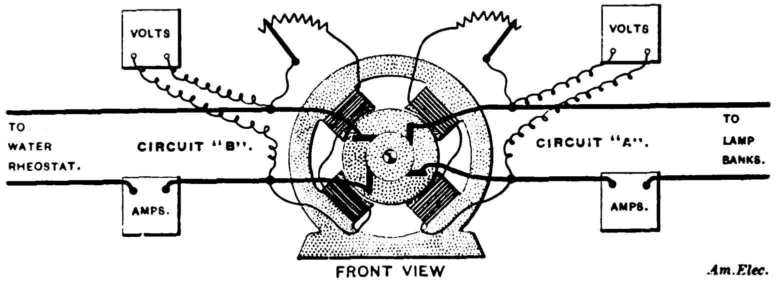


FIG. 1.—MULTI-CIRCUIT CONNECTIONS.

Experiments conducted some years ago by Mr. S. N. Rushmore on the multi-circuit principle have proved the above assumption to be erroneous, and in an arrangement similar to that just described the greater part of the magnetic flux tends to pass only between the magnetized poles, producing a difference in pressure between the brushes collecting on this side proportional to the excitation of the poles, while those on the opposite indicate scarcely any electric pressure except that due to the residual magnetism of the steel.

In this test, which was made at the Stevens Institute of Technology, the dynamo, which was of 20-k.w. capacity, was driven from a suitable source of power by means of the following device: A belt was led from the source of power to a pulley 15 ins. in diameter, placed upon a 2-in. counter-

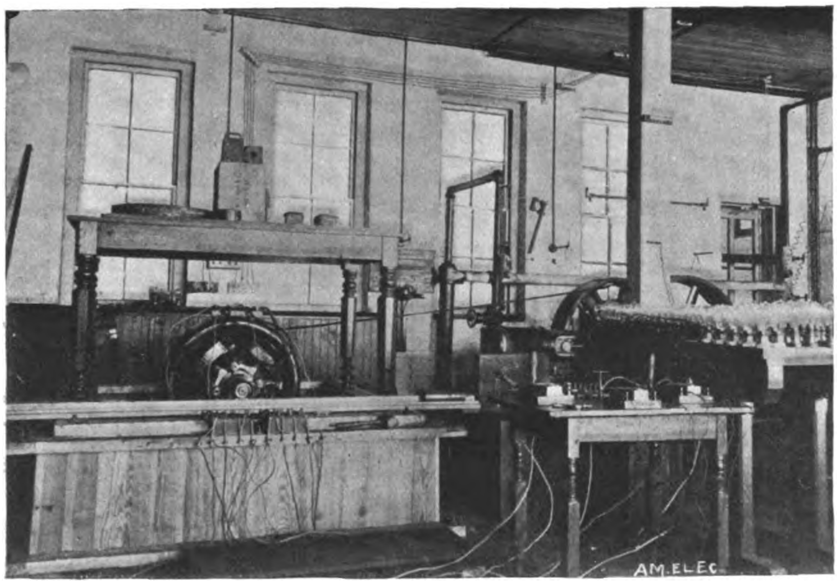


FIG. 2.—ARRANGEMENT OF APPARATUS.

shaft supported by two self-oiling hangers, placed one on each side of the pulley. Upon the end of this countershaft was keyed one-half of a flanged coupling, the other half being fastened to the dynamo shaft. The four bolts were removed from the coupling and in their place four steel pins were inserted to act as drivers. These pins were turned for a portion of their length to such a size as would insure a good driving fit in the holes of the coupling on the countershaft. The remaining length was turned to a size 1-64 in. less than that of the diameter of the holes in the coupling on the dynamo shaft, thereby affording a certain amount of clearance for the pins, and enabling the dynamo to move slightly without undue straining and binding. This was necessary because the Webb floating dynamometer was used, in which, as will be seen by the following description, the machine is likely to become slightly displaced until it is restored by adjusting the counterbalance weights. The dynamometer was one of the floating form devised by Prof. J. Burkitt Webb, of the Stevens Institute of Technology. In this device the dynamo is mounted upon a box or float, which is immersed in a suitable tank of water. The torque of the dynamo tends to tilt the float from a level position, and to restore it a sliding weight must be moved along a scale until a suitably arranged level indicates that the float is horizontal. From the position of the weight with reference to the zero position of the scale and the speed of the dynamo shaft, the h.p. transmitted can be calculated. To float a weight of this magnitude (some 1800 lbs.) it was calculated that a box 4 ft. 6 ins. x 4 ft. 7 ins. x 20 ins. deep was necessary. The tank in which the float was placed was of the same depth, but was 1 in. larger on each side than the inner box.

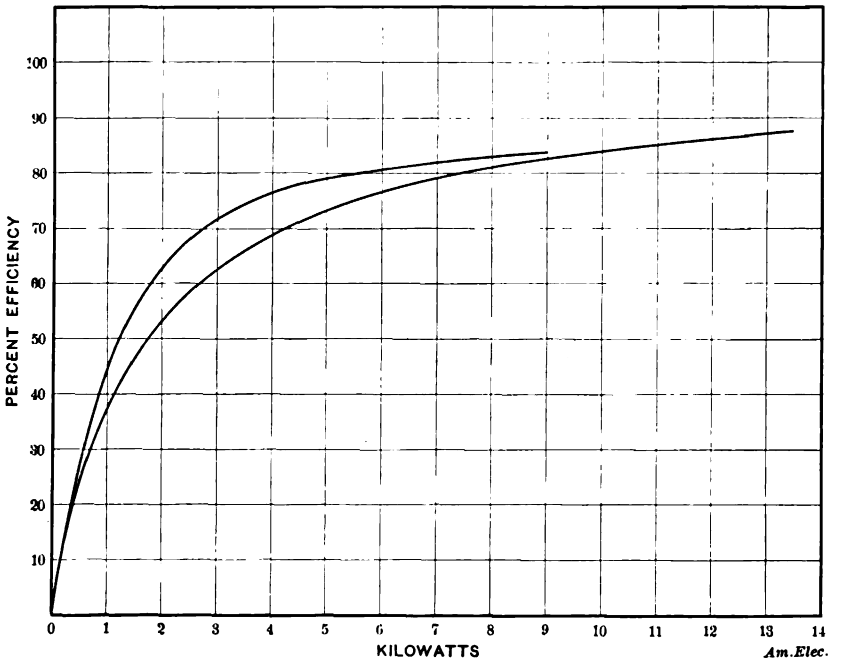


FIG. 3.—EFFICIENCY UNDER MULTI AND SINGLE CIRCUIT WORKING.

The dynamo was securely fastened to the floor of the float and the latter was immersed to about 18 ins. in depth by means of iron ballast placed upon the floor of the float; but it was found that this arrangement made the latter too stable to permit of the reading of small variations in the power. This difficulty was overcome by the expedient of placing a table 3 ft. high upon the float, and the ballast which had been previously fastened below was rigidly secured to the top of the table. This raised the center of gravity to a point nearer the meta-center and rendered the float much more unstable, and hence the dynamometer was more sensitive. The arrangement of the apparatus is depicted in Fig. 2, which shows the machine surrounded by its testing devices. The float was adjusted in a horizontal position by means of varying the position of the weights on the table, the final adjustments in the direction at right angles to the shaft being made by means of a brass clamp attached to the side of the table. The counterbalancing weight slid on a board on which was fastened four half-meter scales placed end to end, making a total length of 2 meters. This board extended in a direction at right angles to the shaft.

It is obvious that the h.p. transmitted is equal to $2 \pi lnw \div 33{,}000$, in which $n =$ number of r.p.m. of the dynamo shaft, l the distance in feet that the weights must be moved from their zero positions to bring the float to a level position, and w the magnitude of the weight used. It is easy to see that by properly adjusting the magnitude of w the meter scale may be made to read directly in foot-pounds, provided that the speed of the dynamo is maintained a certain constant quantity. For this purpose 1000 r.p.m. was chosen and a simple calculation, using the above formula, shows the necessary weight to be 9.7 lbs. In this case it was desirable to measure about 20 h.p. with the weight at the farthest position on the scale, and it was therefore necessary to double the size thus determined and use a pair of such weights instead of one. The power expressed in h.p. was, therefore, the scale reading multiplied by double the r.p.m. and divided by 33,000. This calculation allows for variations in speed.

The speed of the dynamo shaft was taken by a revolution counter, which could be started and stopped accurately on given intervals of time.

The current delivered to circuit B (see Fig. 1) was measured by a Weston direct reading ammeter. The currents in the other circuits were measured by Weston instruments used in connection with shunts. All of the instruments had been tested in the electrical laboratory at the Stevens Institute of Technology and found to be correct.

The current was led from the dynamo by means of wires which connected to binding posts placed along the side of the float. From these short pieces of wire dipped into mercury cups that had been suitably cut in pieces of paraffined wood fastened to the edge of the tank. This arrangement obviated any error that might arise due to the twisting or the springing of the wires, which would exercise a displacing influence on the float. The current in circuit A was absorbed by a series of lamp banks connected in parallel. Each bank consisted of ten 52-volt lamps arranged in five rows of two lamps each in series. In circuit B the current was absorbed by means of a wire resistance made by running a length of German silver wire upon a wooden frame and immersing it in an oil barrel filled with water. From previous experiments it was found that No. 20 B. & S. gage German silver wire would carry a current of 80 amperes for a period of 1¾ hours when arranged in this way. For measuring the voltage fine wires were led out from the binding posts, where the armature terminals were connected to a switch that could connect either pair of wires with the voltmeter at pleasure. The tests made comprised the following:

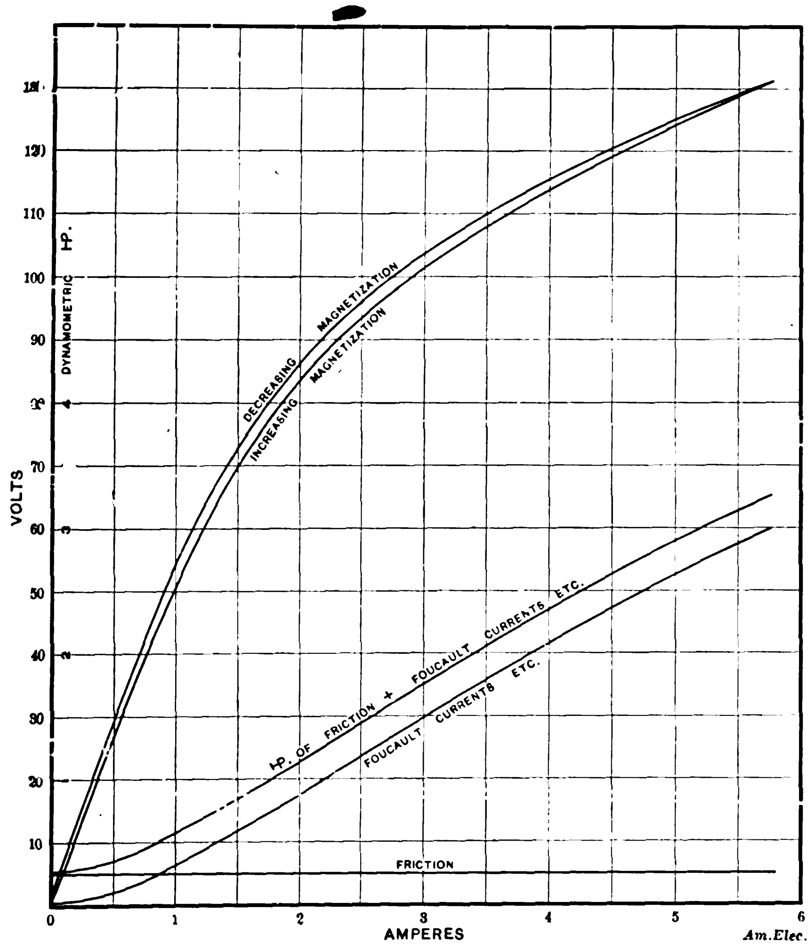


FIG. 4.—LOSS CURVES, ALL POLES MAGNETIZED.

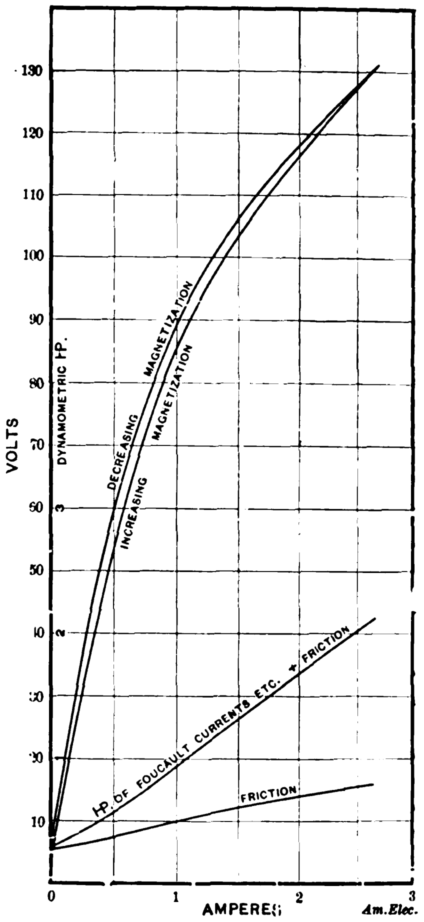


FIG. 5.—LOSS CURVES, OPPOSITE POLES MAGNETIZED.

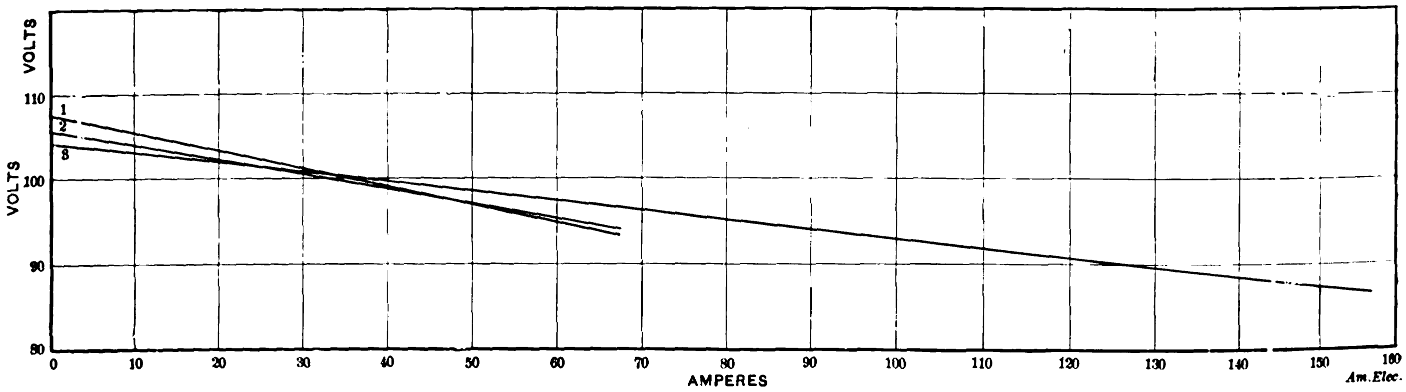


FIG. 6.—CHARACTERISTIC CURVES OF MULTI-CIRCUIT MACHINE.

A. The effect produced upon the voltage of circuit A by varying the voltage in circuit B without altering the external resistance in that circuit.

B. The effect produced upon the voltage of circuit A by keeping the current in circuit B constant, by varying the external resistance and reducing the voltage in that circuit from 110 to 0.

C. A determination of the efficiency of the dynamo when connected as a single-circuit multipolar machine at various loads up to the capacity of the machine.

D. A determination of the efficiency of the dynamo (when connected as a multi-circuit machine) circuit A only was closed and the load raised to a maximum output of 90 amperes.

E. The efficiency of the dynamo when connected for multi-circuit work under the conditions previously given for tests A and B, and also when the current in B is kept constantly at 50 amperes.

F. The amount of power consumed in friction by the bearings and brushes.

G. The power absorbed by the dynamo in Foucault currents, friction and iron losses under various conditions.

H. External characteristics under various conditions of operation.

The variation in the voltage of circuit A when the e.m.f. and current in circuit B are varied is shown in the following tables.

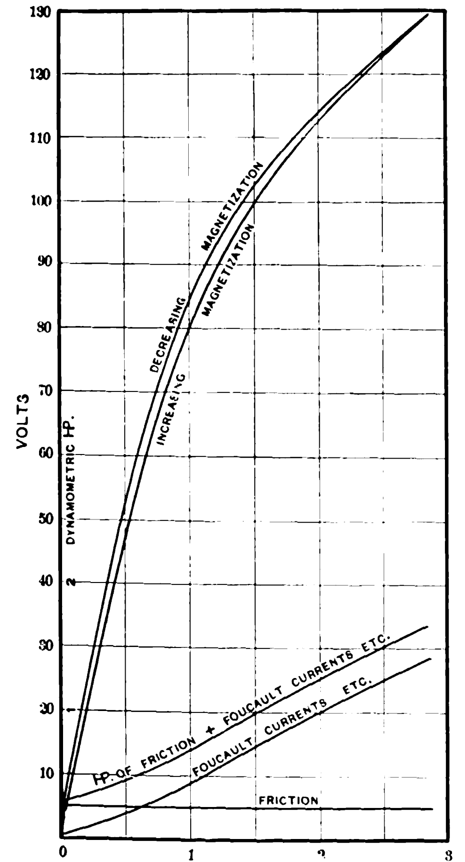
In these tables the results are the average of three readings taken at two-minute intervals. In table A the performance of the machine is shown when the e.m.f. and current in B are varied, the resistance being kept constant. In the case of table B it was endeavored to keep the current in B constant by varying the external resistance; the voltage was lowered in steps in circuit B. The results are interesting, as they show that circuit A is practically independent of circuit B, though from the description of the arrangement it could easily be conceived that the varying of the current and voltage of one circuit might materially affect the output of the other.

TABLE A.

(A)		(B)			
Amps.	Volts.	Amps.	Volts.	Time.	R.P.M.
48.25	96.6	51.2	111.8	2.48 P. M.	931
50	100.6	42	91.6	2.54 P. M.	945
50.7	101.5	32.7	71.6	3.00 P. M.	943
50.5	101.2	24.8	54.4	3.06 P. M.	938
50.25	100.6	13.4	29.3	3.12 P. M.	941
50	100	5	11	3.18 P. M.	943
49.75	99.6	1.5	4	3.24 P. M.	942
50.5	101	0	3	3.30 P. M.	949

TABLE B.

(A)		(B)			
Amps.	Volts.	Amps.	Volts.	Time.	R.P.M.
48.1	101	50.68	113.5	3.34 P. M.	941
48.1	101	50.5	90.5	4.58 P. M.	933
48.7	102	50	70.3	4.11 P. M.	937
48.75	102.5	48.75	47	4.26 P. M.	939
48.75	102.5	50.3	29.6	4.36 P. M.	940
49.3	103.5	51.16	10	4.58 P. M.	941
48.75	102.25	0	3	5.02 P. M.	945



Am.Elec.

FIG. 7.—LOSS CURVES, ADJACENT POLES MAGNETIZED.

The results of the efficiency tests are best shown in the curves depicted in Fig. 3. The longer curve shows the efficiency of the machine connected as an ordinary single-circuit machine. The shorter curve shows the efficiency connected as a multi-circuit dynamo, current being drawn from circuit A only. It is believed that the iron losses of this particular machine were somewhat excessive, due to a defect in its construction noted beyond.

It is but just to the builder to say that this dynamo was an experimental machine and the performance cannot be used as a criterion on which to base the efficiency of similar machines now offered to the trade.

The results of the friction test can be summarized as follows: The power supplied was measured while no current was being drawn from the machine. The average power consumed by bearing and brush friction is equal to .268 h.p., and that consumed by hysteresis and Foucault currents and friction losses when the machine was independently excited to a potential of 100.3 volts across each pair of brushes was found to be equal to 1.75 h.p.

In subsequent tests the losses were eparated, the results being shown in Figs. 4, 5 and 6. In Fig. 4 the losses are shown with both pair of poles connected in parallel and independently excited. In Fig. 5 the same losses are shown with the cross poles independently excited, and in Fig. 7 with the adjacent poles independently excited. The loss due to eddy currents is believed to be somewhat greater than it should be, owing to the fact that the armature was notched with a dull milling cutter, which somewhat impaired the insulation between the individual laminæ.

The external characteristics of the machine were also investigated, the results being shown in Fig. 6. The longer line shows the relative values of current and voltage of the machine connected in ordinary single-circuit fashion. Line 2 shows the external characteristics when the load was divided between A and B, the load on B being constant, while that on A was varied from 0 to 70 amperes, and line 3 shows the external characteristics when current was drawn from circuit A only, circuit B remaining open. These lines are practically straight, although plotted from no less than eight different points in the case of the shorter line and ten different points in the case of the longer line. Each of these points was the average of their readings. The drop in voltage seems to be almost exactly proportional to the amount of current drawn from the machine. The conclusions to be drawn from the results of the tests are as follows:

The commercial efficiency of the machine when connected as a multipolar single-circuit dynamo at a load of 13½ k.w. is 87.1 per cent.

When connected as a multi-circuit dynamo at a load of 13.9 k.w., it is 85 per cent.

When connected for multi-circuit work having no load on circuit B and 6.4 k.w. on circuit A, the commercial efficiency is 81.9 per cent.

The h.p. absorbed in eddy currents and iron losses and friction with all the pole pieces excited is 1.8

The h.p. absorbed in the same losses with two adjacent poles magnetized is 1.23.

The increase of friction with the entire load on one circuit is .28 h.p.

The results of these tests seem to show that the multi-circuit machine is entirely commercial, and that it can be used in many places with great economy, and it seems safe to predict that the day of its introduction in practical work is not far distant.

Types of American Lightning Arresters.

BY HENRY R. RAYMOND.

It has occurred to me that the great dissimilarity in the appplication of similar principles involved in the design of lightning arresters would prove a subject of peculiar interest. The idea of a gap for the discharge to jump, and a preventing or curing arrangement to look after the ensuing rush of dynamo current, seems to have entered different minds from widely different directions, and I have endeavored to give as impartial a description of these differences as possible. It is not the intention of this paper to give any comparative values, and it is probable that what some of the devices lack in one respect they make up in others, and that some makes are peculiarly adapted to certain applications and service, while others are better adapted to other uses. I do not think it wise to attempt the employment of any one type of arrester for both direct and alternating currents.

It will be noticed that but one company recommends the installation of any great number of arresters at any one point, and that further advises a comparatively scattered distribution along pole lines. The more general practice seems to be in the installation of but one arrester for each wire where it enters buildings. It seems that, except for unusually severe conditions, it would hardly be necessary to bunch a number of arresters at any one point, but it is true beyond doubt that under no conditions of overhead operation should lines be protected by a single arrester at either extremity. The exact number and location should be determined for each individual case, no general directions being effectively applicable. The further use of coils of wire wound in series with the line to act as choking or impeding devices is also generally recommended. There are some conditions under which it is advisable to use these impedance coils, but there are others where it would be decidedly of negative value, and more under which little dependence might be placed upon them. In their place they are good, but I think that the general use of these coils is to be discouraged. It is too often the case that coils are placed in circuit, and so much dependence placed upon them that a thorough and intelligent arrester installation is neglected.

The Westinghouse Electric & Manufacturing Company put out an arrester that is self contained in all its action, and depends on no auxiliary devices to present a following arc of dynamo current. The discharging value depends upon the proximity of the electrodes, which are placed as close together and are as few as the designs of the arrester will allow: The non-arcing feature depends upon certain properties of the metals themselves. The total air gap is as small as the arc suppressing qualities of the metals will allow, and in order to prevent the passage of dynamo current the electrodes are made of a composition of certain metals as an alloy. The principal idea of the apparatus is to furnish, in as simple a form as possible, a minimum resistance to the static charge, and a non-arcing device per se.

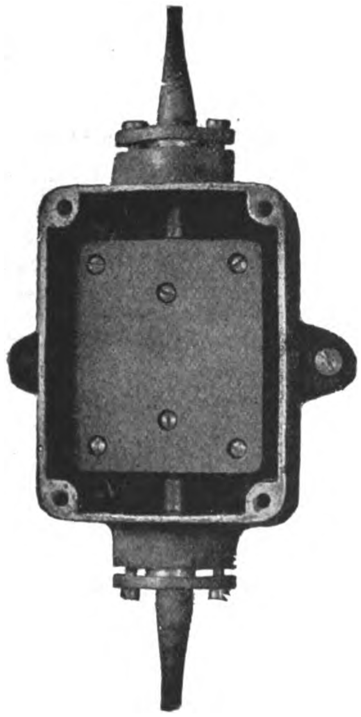


FIG. 1—RAILWAY LINE ARRESTER IN IRON BOX. WESTINGHOUSE COMPANY.

The entire dependence upon the non-arcing properties of the electrodes to prevent an arc from following the discharge, increases the necessary air space slightly, but does not do so to a prohibitive extent, and the potential necessary to start a spark across the gaps is less than with some types on the market.

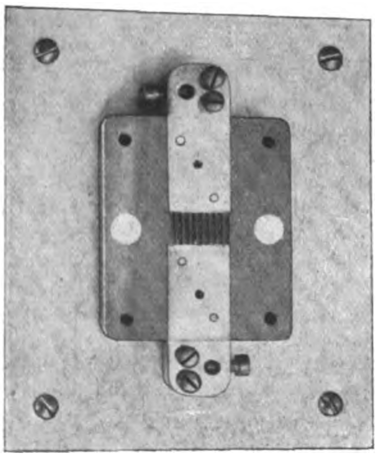
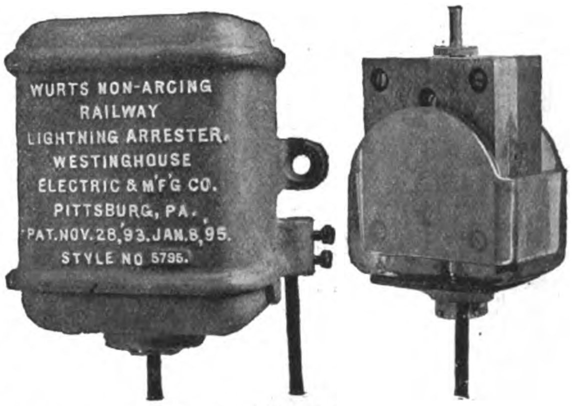


FIG. 2.—RAILWAY STATION ARRESTER. WESTINGHOUSE COMPANY.

Naturally the applications of direct and alternating currents to electrical work demand separate treatment, and this branch of apparatus is not exempt from the general rule. Therefore their arresters are divided into two classes, both, however, based upon the same main principle. The direct current arresters consist of two blunt metal blocks, or "points," which are separated about ⅛ in. These are screwed to a wooden block so as to be flush with the same. The center of this block is slightly charred in little grooves running from the points of the dischargers. This charred wood offers a resistance of about 50,000 ohms, and serves simply as a surface over which the discharges may pass at a pressure much lower than would be required to bridge the gap alone. Another block of wood fastens over the one with metal dischargers, and fits so snugly that the non-oxidizing vapors are confined in the gap. The complete inclosure prevents the volatilization of the metal and the consequent arc. Fig. 1 shows the line type of this arrester in an iron box, with the gap cover still in place. Fig. 2 shows the station type with the gap and charred wood exposed. These types are made in single pole form only. The form of the iron box inclosing this type of arrester being subject to the action of water, should the upper packing become loose, a more effective form was designed, Fig. 3 and Fig. 4. This is modified only in the outer form, the case being an inverted iron box in which the arrester, setting in a glass cup, is inclosed. The ground connection is made directly to the iron case, the arrester being well insulated by the glass cup. In some localities where good grounding is uncertain it is advisable to use temporary but direct grounds, not depending on the gaps entirely. In order to make it a convenient proceeding the Westinghouse Company has produced an arrester, Fig. 5. which connects to the ground through a water resistance. This resistance is contained in a three sectioned tank lined with galvanized iron. A water pipe connection is made which constitutes the ground terminal as well as the means of supply. A small quantity of water is continually flow-



FIGS. 3 AND 4.—PERFECTED FORM RAILWAY LINE ARRESTER. WESTINGHOUSE COMPANY.

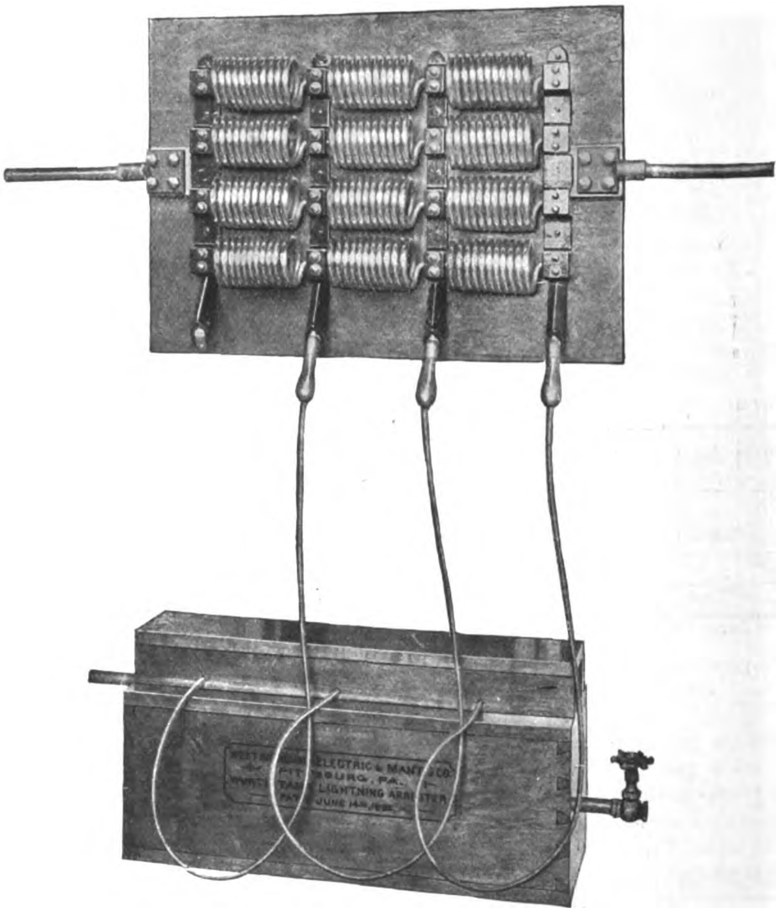


FIG. 5.—TANK ARRESTER, RAILWAY STATION. WESTINGHOUSE COMPANY.

ing from one tank to the other, in such a manner as to make a complete circulation and prevent the forming of salts. The line terminals are flat carbons, suspended in the middle of each compartment. Line connections are made by plugs and flexible cables leading to a choke coil board. The leakage under ordinary conditions is about 3 amps. The plug connections facilitate disconnecting during fair weather.

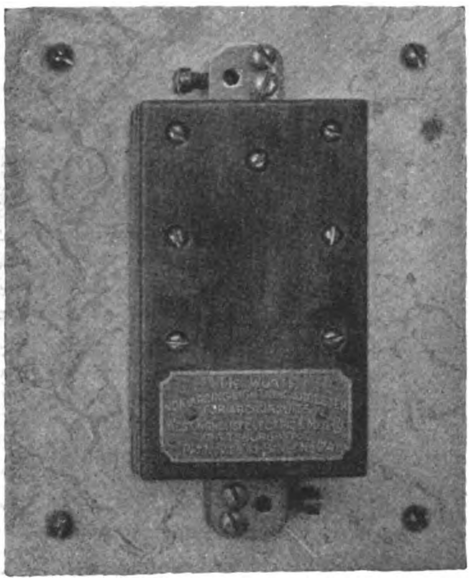


FIG. 6.—ARC ARRESTER, ARC CIRCUIT. WESTINGHOUSE COMPANY.

The arc circuit arrester is shown closed in Fig. 6. This device is practically identical with the 500-volt direct-current arresters shown in Figs. 1 and 2. As it is intended to be used on arc circuits at voltages up to 4000, provision is made for the increased pressure. The gap is not proportionally lengthened, because the current is small and limited.

The alternating current arresters are made likewise of "non-arcing metal," but differ in form, in the length of air space, and in the absence of any conducting material between gaps. In standard form, as represented in the cut shown herewith, they consist of seven cylinders separated 1-64 in. These cylinders are 1 in. in diameter and 3 ins. high. Their surfaces are knurled, possibly for looks, possibly for greater ease in turning them in order to expose different portions, but probably to introduce a number of minute points into the discharge path. The seven point, six gap arrester is designed to be used as a double pole device on 1000-volt circuits, and as a single pole one where the pressures are 2000 volts.

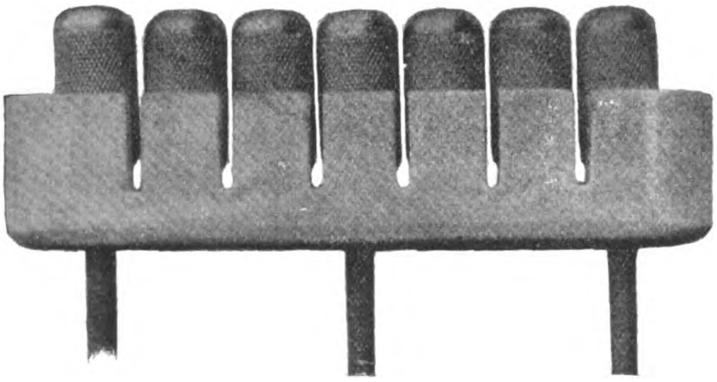


FIG. 7.—CYLINDERS ENCLOSED IN PORCELAIN. WESTINGHOUSE COMPANY.

These arresters in detail consist solely of the metal discharge cylinders and the porcelain or marble support for the same. In the form used for line work, Fig. 7 illustrates the method of holding the cylinders in place. The lower part is assembled by simply placing the dischargers in the hollows molded for them in the porcelain base. The top half slipped on and the arrester complete in an asbestos lined iron box is shown in Fig. 9. The station form, Fig. 8, is not inclosed, and instead of porcelain marble supports the dischargers. These are bolted axially to two marble slabs, which in turn are bolted to the base slab.

The manufacturers of these arresters claim that the method and location of the insallation of arresters is of importance equal to the effectiveness of the type, and it certainly is true that location is one of the vital points in any lightning protecting scheme. They claim that a "flash" of lightning and its kindred disturbances are not simple direct discharges to the earth, but that they are vibrations of enormous frequency and uncertainty of repetition. They state that the discharges do not come with any regularity, and are seldom in unison, believing that the oscillations of one discharge will be acted upon by those of the one preceding or following. Like waves of water, there will be presented both crests and troughs, and when the crests are at one point the resultant will be much higher than either, and that when a trough and crest are coincident the resultant will be a flat or level spot, one partially neutralizing the other. The general effect is supposed to find its analogue in the action of a choppy sea. It is further held that these "choppy" or "splashing" places may be and are very close together, and that they may pass along a line in this state of confusion. If a single arrester per line were the sole protection it is evident that its connection might be at one of the low spots, and that the potential at this point might be too low to bridge the gap, and also that the machine might be at the high point and break down with the resulting pressure. It would appear then that it were necessary to locate these nodal points and so arrange our system that an arrester would be at the crests and the machinery to be protected at the troughs. The claim is that the splashings are constantly shifting about, and that no definite location for their occurrence can be determined. On account, therefore, of this shifting of pressure peaks it is their custom to install such a number of arresters that one at least may always be at a point of high pressure; and to accomplish this they recommend the practice of banking them or placing them in compact groups in multiple on each line.

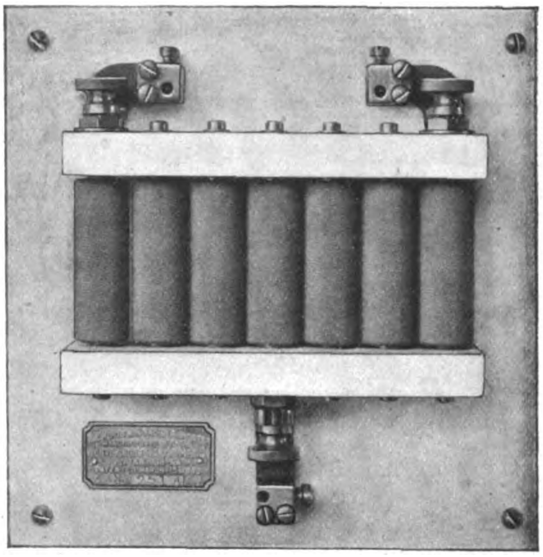
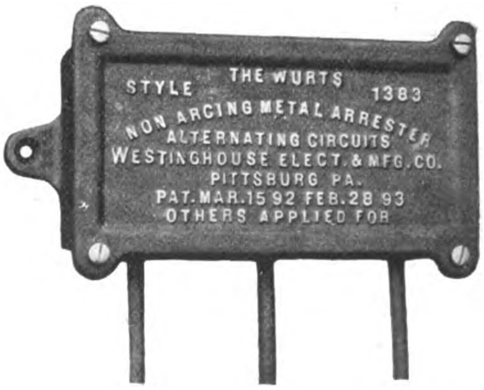


FIG. 8.—CYLINDERS OF ALTERNATING ARRESTER. WESTINGHOUSE COMPANY.


STYLE THE WURTS 1383
NON ARCING METAL ARRESTER
ALTERNATING CIRCUITS
WESTINGHOUSE ELECT. & MFG. CO.
PITTSBURG PA.
PAT. MAR. 15 92 FEB. 28 93
OTHERS APPLIED FOR
FIG. 9.—ALTERNATING ARRESTER IN IRON BOX FOR LINE USE. WESTINGHOUSE COMPANY.

It is common belief that coils of wire in the main line are of advantage in retarding the passage of a high frequency discharge, and this company generally advises the use of these coils in series with the line, so located that an arrester and coil will alt.rnate, as in Fig. 11, which shows one end of a 2000-volt 3-wire power transmission system with bank of arresters and choke coils. Figs. 13 to 17 represent a method they devised to economize on the number of arresters and still have the bank form providing for the selective paths. Each circle represents a coil, each rectangle a unit arrester. Fig. 13 shows four coils in series and one and one-half arresters to ground. Fig. 14, five coils in series and two and one-half arresters to ground. Fig. 15, six coils in series and four arresters to ground. Fig. 16, six coils in series and five arresters to ground. Fig. 17, six coils in series and seven arresters to ground. It will be noticed that in this way about 50 per cent of the installation is saved, and still no lessening of chances favoring the choppy sea idea. They make these forms of installations in a compact form styled type R, the entire combination being mounted in a hardwood crib or frame.

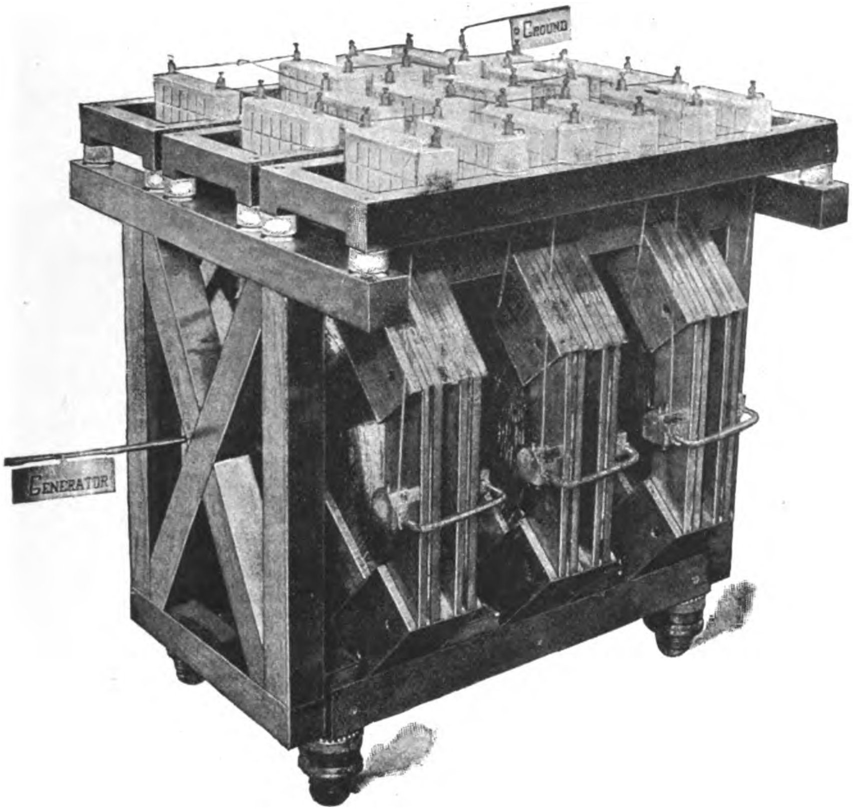


FIG. 10.—ALTERNATING STATION ARRESTER. WESTINGHOUSE COMPANY.

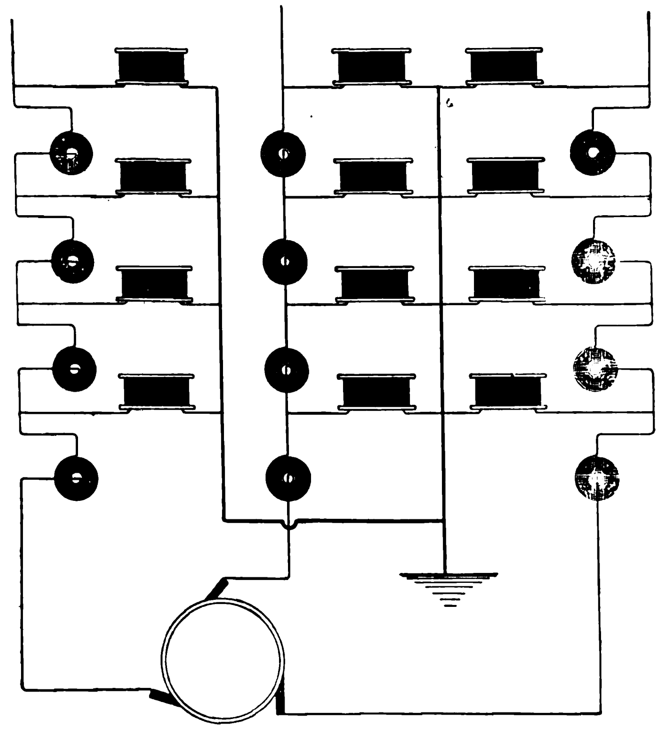


FIG. 11.—ONE END OF 2000-VOLT POWER TRANSMISSION SYSTEM. WESTINGHOUSE COMPANY.

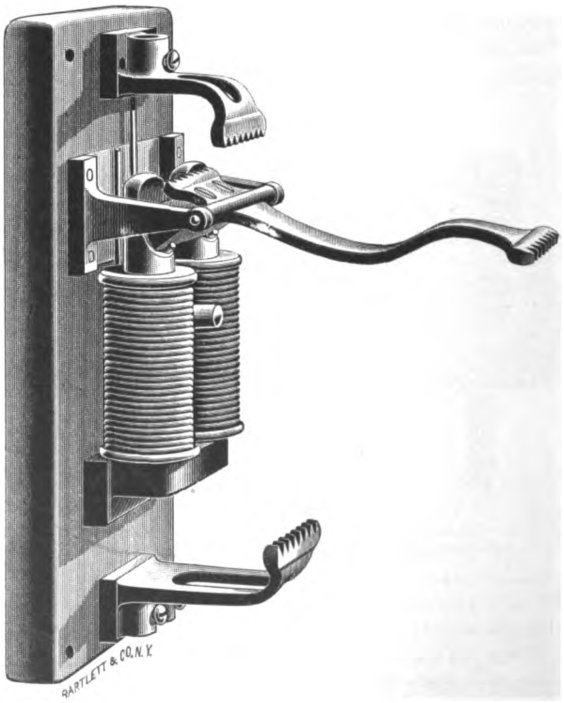

BARTLETT & CO. N.Y.

FIG. 12.—ARC ARRESTER, FORT WAYNE CORPORATION.

Any description of the "Wurts" apparatus which is manufactured by the Westinghouse Company would be incomplete without a mention of the peculiar properties of non-arcing metals and their discovery by Mr. Wurts. He conceived the idea that a device which, when the discharge was followed by dynamo current, instantly short-circuited the system and as quickly removed the short circuit, would effectually prevent the sustenance of the arc. He placed some carbon discharge points across the terminals of an alternator. This gap was 1-16 in. in length. In shunt with the same was a device which was to short circuit the system and at once open again. The current was thrown on and the test showed partial favorable results. It was found that the carbon dischargers would heat to such a degree that an arc would start again across the heated vapor and keep the affair in continuous operation. Trying to overcome this trouble by the use of metal instead of carbon, he found that some metals would interrupt the passage of current without the short circuiting device, and that others would melt like butter. Further investigation brought to light the fact that the composition of the metals was the leading factor, and that alloys of zinc and antimony were the most common possessing this property. The principal metals consist of zinc, cadmium, mercury, antimony and bismuth, and their alloys or amalgams. It was further found that the dischargers must be within a certain distance to exhibit this property, and preferably of such shape and position that any vapor would be held in the gap. The explanation is that the heat of the incipient arc volatilizes a small portion of the metal, and that the oxide so formed is non-conducting. This non-conducting vapor when confined between the terminals offers a barrier of so great a resistance to the arc that its maintenance is impossible.

The "Wood" arrester, manufactured by

the Fort Wayne Corporation, is one of the type depending upon mechanical movement to break any following arc. The arrester, Fig. 12, is for use on arc circuits. As is evident from the cut, the circuit is so arranged that both line and machine terminals connect to the lower part of the arrester. The ground path from thence consists of the two gaps, the lever and the upper contact, which is in direct connection with the ground wires. As shown in the cut the arm is "open." When in normal inactive condition, however, it hangs in a vertical position, so that the upper points of each gap stand directly over each of the lower terminals. When a discharge passes the described path, it is followed momentarily by the dynamo current. The magnet is connected across the upper gap, and the drop across this gap drives enough current through these coils to draw down the armature attached to the arm. This movement throws out the lower end of the arm, which draws out the arc to such an extent that it is at once broken.

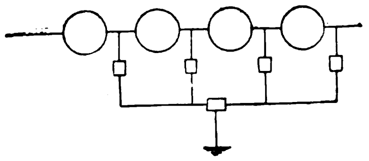


FIG. 13.

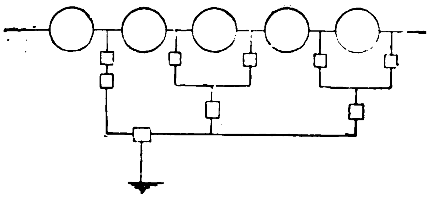


FIG. 14.

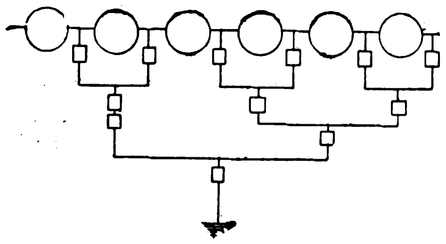


FIG. 15.

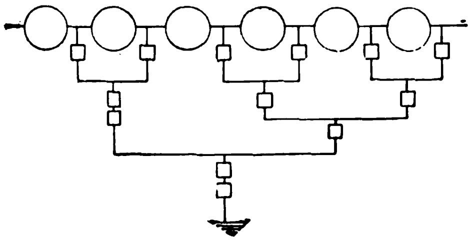


FIG. 16.

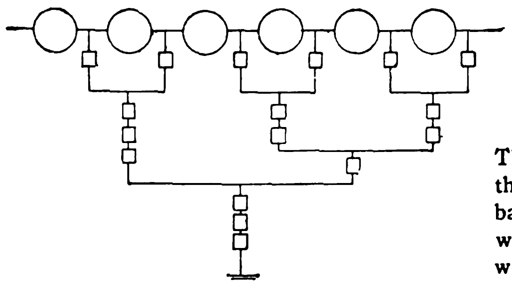


FIG. 17.

FIGS. 13 TO 17.—METHODS OF TERMINAL CONNECTION USED BY THE WESTINGHOUSE COMPANY.

ARMATURE WINDINGS AND CONNECTIONS.

TELESCOPE WINDINGS.

BY PROF. ARTHUR L. RICE.

In some dynamos, which are to be used for low voltage and for large currents, as, for instance, machines which are to furnish current for electro-plating purposes or for welding machines, it becomes a difficult matter to make the conductors and commutator bars sufficiently large to carry the current without dangerous heating. For such machines the telescope or multiple winding is adopted. In principle this consists of several separate windings, with the conductors and commutator bars of the several windings arranged side by side on the same armature, but not connected. The windings are then put in parallel by the brushes, which extend over as many bars as there are separate windings. Two windings in parallel are called a double winding, three a triple winding, and so on.

Three or four separate circuits are as many as will usually be necessary to carry the current safely; of course the fewer there are the less the complication of the armature. On the other hand, for large currents, the more wires used in parallel the smaller can be the wire, and a small wire winds on much more easily than a large one. Also, it is much easier to build up a mechanically good commutator if the bars have sides which are not too far from parallel than if they are quite decidedly wedge shaped. If few bars are used for large currents they must have large bearing surface, and that means that the commutator must be of large diameter or of considerable length, or else must be made of bars which are thick at the outside and thin at the inside edge. None of these conditions are good either from the standpoint of mechanical construction or from that of cost. It is better to use several bars in parallel, and the easiest way to do that is to use several windings on the armature.

Suppose that the case be taken of a four-pole machine to be wound as a four-circuit machine with a triple telescope winding; forty-eight conductors in two layers. There will be 48 ÷ 3 = 16 conductors in each winding; this makes eight coils, and therefore eight commutator bars will be needed per winding, or 8 × 3 = 24 bars in all. If this is to be a wave winding the pitch will be either; 16 = 4 × pitch + 4; 12 = 4 × pitch; pitch = 3; or 16 = 4 × pitch − 4; 20 = 4 × pitch; pitch = 5. Let 5 be taken as the pitch both front and back.

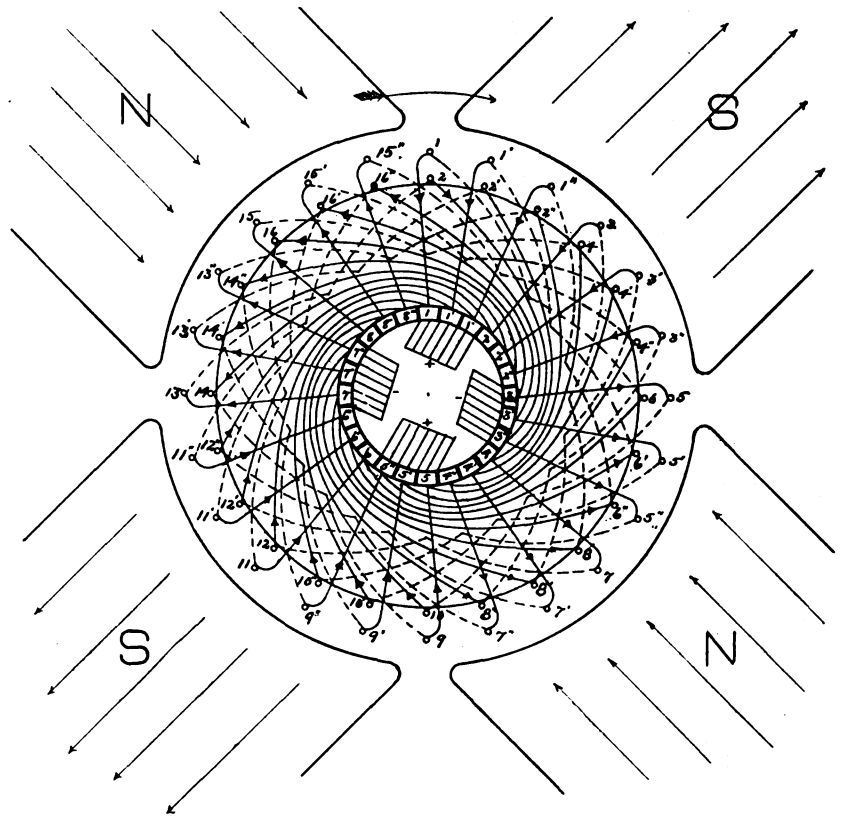


FIG. 1.—FOUR-POLE, FOUR-CIRCUIT, TRIPLE WAVE WINDING; DRUM ARMATURE.

Turning for a moment to Fig. 1, and starting at bar 1, every third conductor and every third bar will belong to one winding; i. e., those numbered 1, 2, 3, etc. The same will be true if 1′ be taken as the starting point, and 1′, 2′, 3′, etc., will be included in the second winding; the same is true for the third if the start be made at 1″.

For the first winding the connection is from:

Bar	1	to	Cond.	1	to	Cond.	6	to
"	6	"	"	11	"	"	16	"
"	3	"	"	5	"	"	10	"
"	8	"	"	15	"	"	4	"
"	6	"	"	9	"	"	14	"
"	2	"	"	3	"	"	8	"
"	7	"	"	13	"	"	2	"
"	4	"	"	7	"	"	12	"
"	1							

and a closed circuit has been formed. The directions of the e.m.fs. may be traced and the positions of the brushes determined as shown in Fig. 1.

If the second circuit be now considered, the connections will be:

Bar	1′	to	Cond.	1′	to	Cond.	6′	to
"	6′	"	"	11′	"	"	16′	"
"	3′	"	"	6′	"	"	10′	"
"	8′	"	"	15′	"	"	4′	"
"	5′	"	"	9′	"	"	14′	"
"	2′	"	"	3′	"	"	8′	"
"	7′	"	"	13′	"	"	2′	"
"	4′	"	"	7′	"	"	12′	"
"	1′							

and another closed circuit has been formed. The same process, starting at bar 1″ will result in the third closed circuit.

The three lie side by side on the armature and may be connected in parallel by brushes which join the three bars, 1, 1′, and 1″, so that there will be safely available three times the current which one winding could furnish, at the same voltage as would be given by the single winding.

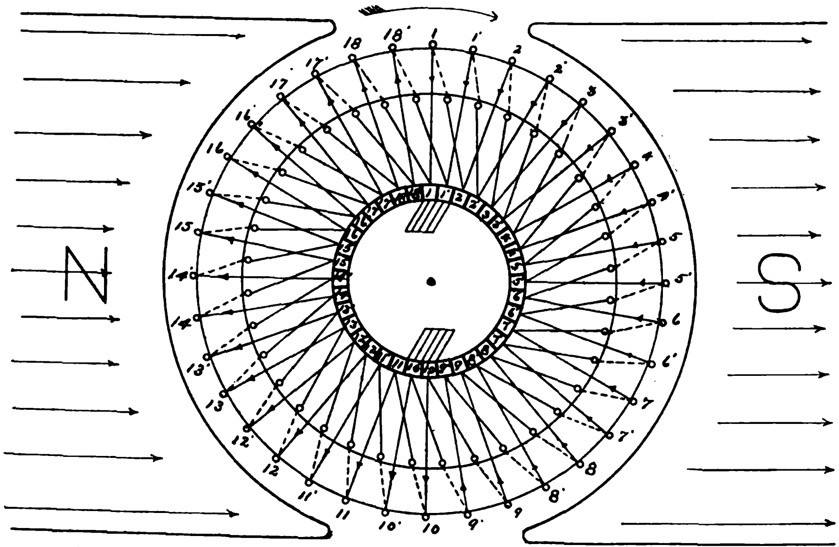


FIG. 2.—TWO-POLE, DOUBLE WINDING; GRAMME RING ARMATURE.

For another illustration, let there be taken a two-pole ring wound machine with thirty-six conductors in a double winding. Remember that, for a ring armature, the conductors are counted only on the outside of the core, and that a conductor stands for a coil. There will be $36 \div 2 = 18$ conductors or coils, and eighteen bars per winding, or thirty-six bars in all. Every other coil and bar will be part of one winding, and the alternate coils and bars parts of the other winding. Each coil will be connected to the ones in the same winding next it on each side through leads to the commutator.

Referring to Fig. 2, starting at bar 1, the connection goes to coil 1, then to bar 2, to coil 2 and so on around to bar 1. For the other winding, starting at bar 1′, the connection goes to coil 1′, then to bar 2′, then to coil 2′, and so on around to bar 1′ again, forming a second complete circuit. The two circuits are put in parallel by broad brushes covering at least two bars. From this winding there could be taken twice the current which would be available from a single winding, and at the same voltage as would be given by the single winding.

There is a limit to the application of this principle of telescope windings, which is indicated by the fact that the two windings of the second illustration do not occupy equivalent positions under the poles. It is still more noticeable in the first illustration, where the winding 1, 2, 3, etc., has quite a different position in relation to the poles from that of the winding 1″, 2″, 3″, etc. If the subdivision into parallel windings be carried very far, the difference in position and the inequality of the strength of the field at different points under the pole faces will result in the production of unequal e.m.fs. in the several parallel circuits, and there will be a tendency for current to flow from one to the other, causing bad sparking at the brushes. But, if there are not more than four circuits in parallel, and if the distance from a conductor of the first winding to the corresponding conductor of the last, i. e., 1 to 1″ in Fig. 1, be small, as compared to the width of the pole face, no serious trouble will ensue from the use of this form of winding.

◆

THE ELECTRIC SIREN.

In electrically propelled conveyances, such as cars, automobiles, locomotives or electric launches, there has always been a tendency, if some signal device akin to a whistle was desired, to provide a motor and air compressor for its operation. The noise produced by the device is not intended to delight the musical ear, but rather to act as a long-distance warning, and it seems strange that in this connection no one has thought of an electric siren built on the following plan:

It is a well-known fact that any magnet excited by alternating current emits a humming noise. If a thin sheet of iron be placed over it for immediate contact, the volume of sound will be a revelation, and if the iron sheet is mounted with a frame so as to form a diaphragm and the magnet be made sufficiently powerful and operated at a suitable frequency, a most piercing, penetrating noise is emitted, which can be heard for miles, and especially is this the case if the sound thus emitted is collected and transmitted by some device of the megaphone character. A very small rotary transformer will serve to supply the current to operate such an instrument, and would be immeasurably lighter than the electric compressor or equipment necessary to operate an equivalent whistle. The control would be accurate and easy and the pitch of the sound could be modulated, thus rendering a simple and more extensive signal code posible. The sound, it is true, would be weird and uncouth, but scarcely more so than that of modern steam calliopes, which are so popular on high-speed steam yachts owned by wealthy men.

It may be added that steam whistles of all kinds are enormously wasteful of power. For example, a prominent manufacturing company a few years ago reduced the size of the whistle on its works and shortened the time of blowing, because of the serious reduction of boiler pressure caused by operating the whistle for four minutes every morning. Applications have been made to the Government authorities for permission to shorten the length and reduce the frequency of the whistle blasts prescribed by law for foggy weather, because of the serious waste of steam.

When the expensive process of air compression is added to the already wasteful method of using the compressed fluid, it will be seen that the efficiency of the modern whistle in foot-pounds per sound unit, if such conception were possible, is very poor indeed.

The electric siren would always have the advantage of being less likely to get out of order, and water-logging would be an impossibility. It is not an infrequent occurrence for a pilot to be considerably embarrassed on account of being unable to make audible signals due to water in the whistle. For small work, to replace the familiar electric bell, the electric siren is an entirely feasible device. An ordinary telephone receiver attached across a 52-volt alternating circuit will quickly convince the experimenter of the noise-making possibilities of such apparatus. For signalling on board ship, where much depends on the working order of the calling device, such a system presents many advantages. There is no vibrator to get out of order, and the possibility of the failure of the instrument to respond to current is very remote. Shipboard signals are now operated by rotary transformers of direct-current type. Alternating rotary transformers are just as feasible.

Still another advantage of the electric siren is the ability to control it at great distances. The ordinary system of fire bells prevalent in many towns could be replaced by one of electric sirens, which would be controlled directly from current supplied by the local lighting company, without the use of relays or other devices likely to get out of order. The development of the device will be interesting, and the field for it, though not large, is undeniably existing.

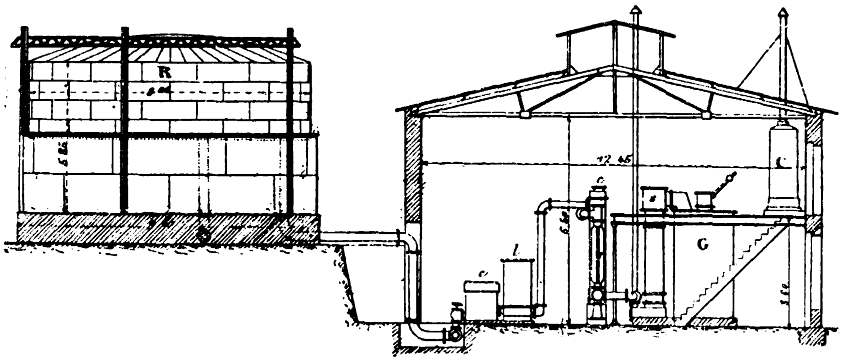
As a unique device for making a barbarous noise on the Fourth of July and similar patriotic occasions, an improvised electric siren has on several occasions eclipsed anything which has ever come to the writer's attention, but it does not seem either impossible or absurd to utilize its power to better advantage in useful fields.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Producer Gas in a Railway Power Station.—An exceedingly interesting installation, in which gas-engines supplied from producers are used, is described in "Le Génie Civil." The high price of coal at Lausanne (Switzerland), where this station is located, necessitated the most careful precautions against waste of fuel, and close consideration of various methods of saving. It was finally decided to use producers and gas engines, the plant having been erected under a strong guarantee that it would show a consumption of less than 1.375 lbs. of coal per h.p.-hour of actual output.

The installation comprises three Crossley two-cylinder gas engines of 130-h.p. each, direct connected to Thury dynamos giving 600 volts at 160 r.p.m. A cross section of the plant through the gas-generating and storing part is shown in the illustration. Two small boilers, C, furnish the necessary steam. The generators, G, are provided with a revolving sole-plate and have no grates. On the sole-plate a thick layer of cinders is laid, the mixed air and steam being injected into the middle of this mass and finding its way out through the fire, which is kindled directly on the top of the cinders. As combustion proceeds the fire burns upward, leaving an increasing thickness of cinders. Once an hour or so the sole-plate is rotated and some of the cinders discharged into an ash-pit, which is emptied about twice a week. The process is entirely continuous. The gas passes from the generator through a system of coolers, washers and purifiers to the gasholder, R, of about 175 cu. yds. capacity.



GAS PRODUCERS IN THE LAUSANNE STATION.

Water for cooling the engine cylinders is kept in a cistern on a nearby hillside, and after circulating around the cylinders is returned by means of a motor-driven pump, its cooling being effected by spraying as it enters the cistern. A battery of 300 cells of Pollok accumulators, of 700 ampere-hours' capacity, completes this admirably economical station.

The system worked comprises 25 cars running on 8.3 miles of track and what are said to be the heaviest grades and shortest curves on any European tramway, the former having a maximum of 11.3 per cent. The plant has been in successful operation for two years. During the first half of the current year the coal consumption is stated to have been 2.05 lbs. per k.w.-hour, this figure including all the coal burned in any part of the plant for any purpose.

Rates of Wages in France.—In a recent number of the "Revue des Transports Parisiens" is published a memorandum of the rates of wages to be paid laborers and workmen engaged upon the new Métropolitain, or underground railway, now being constructed in Paris. These rates are so much less than those commanded by the same labor in this country that they furnish an interesting comparison. The advertised rates are as follows: Foremen, for all classes of work, 17 cents per hour; laborers with pick, shovel or scraper, 12 cents per hour; rollers, hod-carriers, road levelers, rammers, messengers, helpers, etc., 11 cents; stone masons, bricklayers, cement mixers, pavers, 16 cents; second-class bricklayers and firemen, 12 cents; stone cutters, dressers, etc., 18 cents; shaft sinkers, miners and quarrymen, 15 cents; carpenters, glaziers and painters, 16 cents; smiths, horseshoers, wheelwrights, tinners, roofers, plumbers and enginemen, 15 cents; drivers, 10 cents. At night the wages for each of these classes are one and one-half times the rates above. One-horse carts, without driver, are hired at 18 cents per hour; two-horse carts, drays or wagons, at 32 cents, and three-horse vehicles at 46 cents. For men working at night or underground an allowance of 1 cent per hour is made for lights, which the men furnish.

In comparing these prices with American wages the most remarkable difference, after their generally low average, is the distribution of wages and trades. For example, an engineman there receives less than a carpenter and only 25 per cent more than a common laborer.

Magnetic Surveying for Iron Ores.—At a recent meeting of the Iron and Steel Institute at Stockholm, Prof. G. Nordenström read an important paper giving a description of the magnetic survey methods in use in the Swedish iron ore districts. An abstract appears in the (London) "Electrical Engineer." The most usual instruments are Thalén's magnetometer and Tiberg's inclinometer. The former is shown in plan in Fig. 1. It consists of an ordinary compass, similar to the old-fashioned surveyor's compass, provided with a scale graduated from zero to 90 degs. An arm, B, is attached at right angles to the diameter passing through the zero points of the circle, and on this a permanent magnet, C, is mounted so that its distance from the needle may be altered at will. The instrument is used either as a sine magnetometer or as a tangent instrument. For the latter the needle is placed at zero, after the instrument has been leveled and the magnet removed. Then the magnet is replaced and the angle of deviation is read. In using the sine method the needle is adjusted to zero with the magnet in place, and the deviation caused by the removal of the magnet is noted.

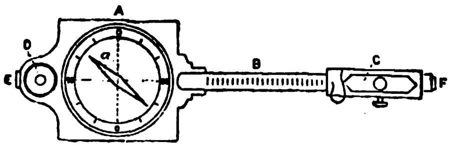


FIG. 1.—PLAN OF MAGNETOMETER.

The Tiberg inclinometer is simply a dipping needle, counterbalanced and provided with a permanent magnet similar to that just described, which compensates for the horizontal component of the magnetic field and allows only the vertical component to act.

To explore a field for ore the ground is staked off into squares about 10 meters (32 feet) on a side, and a reading is taken at every corner of every square with one or the other of the above instruments. If the magnetometer is used a plot of the ground is made and all the points of equal declination are connected together by curves, as shown by the heavy lines on the ideal map. These will be found to be arranged in two systems, grouped with more or less regu-

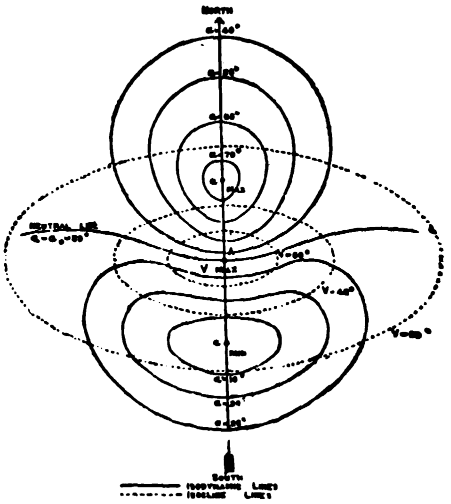


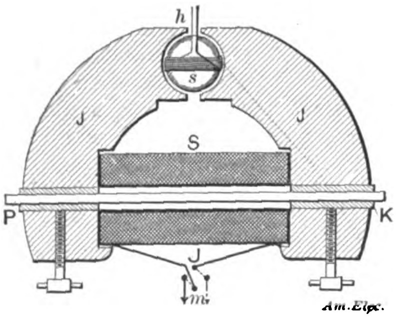
FIG. 2.—IDEAL MAP OF ORE-BEARING REGION.

larity around two foci. One of these is the point of maximum declination, and is situated north of the main body of ore, the other being the point of least declination and situated either south of the main body of ore or just above it. Between the two groups of closed curves is one open curve, called the neutral line, and whenever certain conditions of the angular value of the minimum and mean deviations are satisfied the main body of ore is situated at the intersection of this line and the line connecting the maximum and minimum points.

With the inclinometer similar curves are plotted, shown on the map as dotted curves. These will be found to be grouped concentrically around a point below which is the greatest mass of the ore.

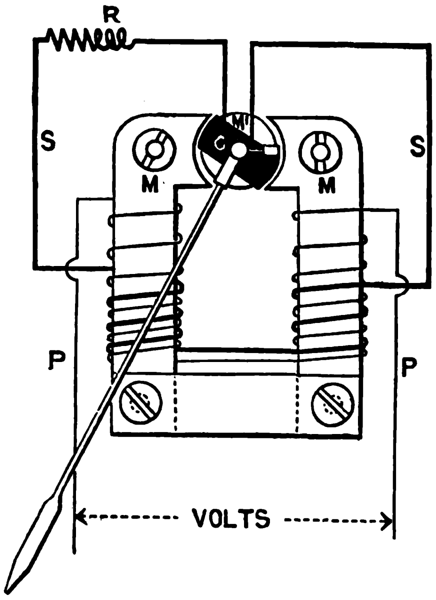
These methods are said to work as well in Southern latitudes as in Sweden. Of course this method of survey is only applicable to a magnetic ore, but as large quantities of magnetite are found in this country it is possible that the simple instruments described above may be found useful.

An Industrial Permeameter.—A new form of instrument for measuring the magnetic constants of samples of metal is described and illustrated in "L'Electricien." The principle of the instrument is similar to that formerly employed by M. Marcel Deprez, and consists in reversing the action of a Deprez-d'Arsonval galvanometer. The figure shows the instrument in plan. Between two stout polar pieces of iron, J J, is a movable coil of the d'Arsonval pattern, s, through which a constant small current is allowed to flow. Clamped securely between the polar pieces is the sample to be tested, P K, which consists of a bar of the metal carefully turned to size. This is surrounded by a magnetizing coil, S. On the polar pieces, J J, are wound also coils of a few turns, not shown in the illustration, which are used to compensate for the disturbing effect upon the magnetic circuit of the current in the movable coil. A coiled spring tends to maintain the needle attached to the moving coil at its zero position, and the deflections caused by currents of known intensities in this coil and the magnetizing winding, S, furnish the data from which the permeability of the specimen under test is calculated. The instrument is said to work very satisfactorily up to inductions as high as 20,000 gausses in the specimen.



INDUSTRIAL PERMEAMETER.

A New Alternating Current Voltmeter.—Mr. Arthur C. Heap describes, in the (London) "Electrical Review," a new form of alternating current ampere or voltmeter, designing to be free from errors due to wave form or periodicity. It consists of a magnetic circuit of laminated iron, as shown in the illustration, the yoke part being made removable so that the coils can be slipped on. In the space between the poles is a cylinder of laminated iron, leaving a small air gap on each side. In this space turns the pivoted coil, C. A winding of fine wire on the frame is connected with the source of current to be measured. Over this is wound a coil connected with the turning coil, C, and a resistance, R. The secondary current induced in the coils on the frame passes through the pivoted coil, which is thus caused to move in the field due to the primary turns. In order that the indications may be free from errors due to wave form and periodicity it is necessary that the magnetic leakage should be small and remain constant, hence the air gap is made as small as possible. The instrument is said to be remarkably constant and free from errors.



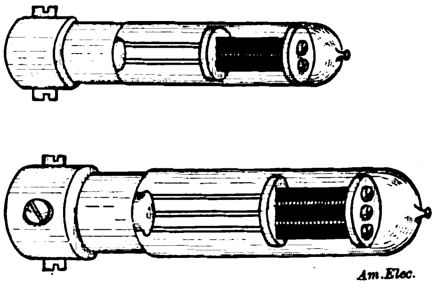
AN ALTERNATING CURRENT VOLTMETER.

Relative Costs of Conducting Wires.—In the (London) "Electrical Review" Mr. John B. C. Kershaw reviews the present comparative costs of copper, iron and aluminum conductors for equal electrical conductivity. He takes issue with recent publications on this subject, in which it is claimed that aluminum and copper for the same conductivity are about equal in cost, since this assumes the conductivity of the aluminum to be that of metal 100 per cent pure. Mr. Kershaw takes the present market prices as copper, 12.064 cents per pound; aluminum, 32.1914 cents per pound (the conductivity of the metal being taken as 0.59 that of copper, or that belonging to 99 per cent aluminum). Iron is taken at £3 12s. per long ton, or 0.783 cents per pound, and its conductivity at 16.4 per cent of that of copper. To the cost of iron is added 38 per cent for rolling. The following figures show the comparative costs, as calculated, for conductors of the same conductivity:

Aluminum, 99 per cent	375
Copper, electrolytic	278
Iron, rolling cost included	100

Vacuum-Tube Lamps.—Herr H. Ebert describes in "Wiedemann's Annalen" (abstracted in the "Electrician") some experiments upon the current consumption of vacuum-tubes. He used high-frequency alternating currents, not obtained in the usual way by the oscillating discharge of a condenser, but directly generated by a dynamo of special construction giving a frequency of about 1000 cycles per second. A step-up transformer was included in the circuit, the pressure at the terminals of the tubes being 1000 to 2000 volts. For a long discharge tube the following results were obtained: Continuous current: volts, 64; amperes, 1.81; watts, 116. Low pressure alternating current: volts, 33; amperes, 1.05; watts observed, 27; C^2R losses, 1.3; hysteresis loss, 1.0; phase displacement, 50 degs. 29 min. High-pressure alternating current: Volts, 2200; amperes, 0.01; C^2R losses, 1.4; consumption of tube, 20.6 watts. This tube gave a perfectly steady light of about 16 c.p. The actual watts consumed compare very favorably with the incandescent lamp, but not so the apparent watts.

Lightning Arresters for Feeble Currents.—The difficulty of properly protecting telephone, telegraph, and other lines using currents of small intensity against lightning has given rise to some very ingenious instruments, among which may be classed the two described in "L'Eclairage Electrique." In one of them the air-gaps are made between a pile of thin, flat carbon plates, separated by thin and narrow strips of mica. A considerable number of these plates are piled up, alternate carbon plates being connected to the line and to the earth. If both sides of a circuit are to be protected the earth plates alternate between those of opposite polarity. This arrangement is said to give excellent results on account of the large exposed surface of the carbon plates.



VACUUM LIGHTNING ARRESTER.

A more ingenious instrument is the vacuum arrester illustrated herewith. Two or three small carbon blocks with serrated edges, separated by a very small interval, are sealed up in a glass tube from which the air is partly exhausted. The well-known property of a partial vacuum for the conduction of high tension currents is utilized, the instrument allowing accumulated charges of high potential to leak off and silently discharging the line. Another glass tube containing a platinum wire of about No. 34 gage is connected in series with this arrester to act as a fuse in case of a cross with a line carrying heavy current at high tension.

The Influence of the Silent Discharge on Air.—The (London) "Electrical Review" abstracts and comments upon Messrs. Shenstone and Evans' paper on the results of their researches into the alteration of the chemical composition of air under the influence of the silent discharge, recently read before the Chemical Society. It appears that the formation of nitric peroxide as well as ozone has been for a long time well known. After describing a method adopted for the detection of this nitric peroxide in the presence of ozone, the authors seek to answer these questions: What is the highest yield of ozone that can be obtained from air under the most favorable conditions? At what stage is nitric peroxide first formed, and what is its subsequent history? What influence has moisture on the various phenomena under investigation? The conclusions are summarized as follows:

Oxygen, when diluted with nitrogen, furnishes a larger proportion of ozone than the pure gas, the proportion ozonized being as high as 98 per cent of the total oxygen present. If the process of ozonizing air is not carried too far nitric peroxide will not be formed. At a certain stage in the ozonizing process, depending upon the temperature and the amount of water vapor present, the nitric peroxide begins to appear. The presence of water vapor is highly favorable to the process of ozonization. As soon as the nitric peroxide appears the ozone rapidly disappears, it and the peroxide gas having a mutually destructive reaction. The destructive effect is not noticed at temperatures below the freezing point of water, except under the influence of the silent discharge. The potential difference used in these experiments was 13,000 volts. It was not found possible to say what proportion of nitric acid is formed by the action of the nitric peroxide upon the water present, but the authors seem to lean to the view that no appreciable quantity is generated.

Long Sparks.—M. Toepler describes in the "Journal de Physique" an arrangement by which he obtained sparks about 6 ft. long. Each terminal of a powerful Toepler influence machine is connected to one of the coatings of a battery of condensers, the other two coatings of the two batteries being connected through the primary of a high-frequency transformer. The secondary terminals of this are in contact with one side of a large glass plate, the other side of the plate being covered with tin amalgam. Sparks leap along the surface of the glass, some of them thus produced by the author being over 6 ft. long.

Alternating Current Heating Apparatus.—Some new types of electric heating and cooking apparatus are described, in "L'Eclairage Electrique," by M. R. B. Ritter, their peculiarity being that they are for use on alternating circuits only and that they utilize Foucault currents set up in heavy masses of metal or in the body of the utensil itself, and do not depend upon any C^2R heating of the conducting coils for their operation. Fig. 1 shows a cooking utensil in plan. Coils S S are wound on the laminated core M M, and the vessel, G, of massive iron, is placed in the polar opening. It is traversed by heavy currents and is also heated somewhat by hysteretic friction. The shields J J are inserted to protect the coils from excessive heating. A simple form of smoothing-iron is shown in Fig. 2. The base of the utensil is a solid iron casting, and on this rests the laminated core, E, carrying the coil, S. Copper rings, K K, contribute to the circulation of current in the apparatus. A very satisfactory form of water bath is shown in Fig. 3, the heat being produced in the heavy cast-iron rings surrounding the coil, S. In the case of this instrument and the smoothing-iron described above the insulation of the coil must be fireproof. In the utensil shown in Fig. 1 it need be only of ordinary material and the wire may be made, in all cases, much larger and less delicate than in apparatus working on the usual principle under commercial voltages.

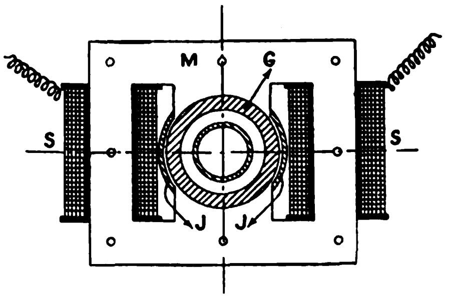


FIG. 1.—ELECTRIC COOKING UTENSIL.

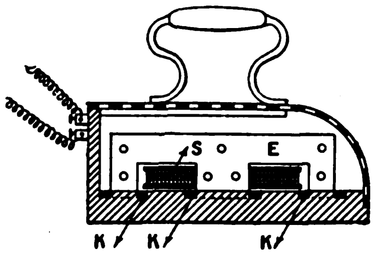


FIG. 2.—ELECTRIC SMOOTHING IRON.

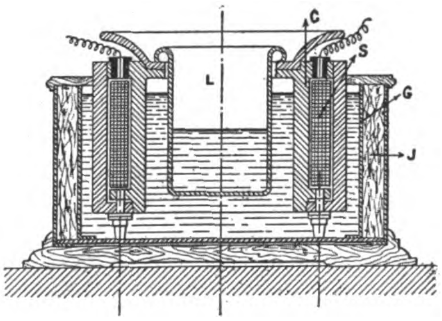


FIG. 3.—ELECTRIC WATER BATH.

The New Telephone Exchange in Paris.—Mr. Mervyn O'Gorman describes, in "Lightning," the new La Villette telephone exchange in Paris. Situated in a trade center, it is the busiest exchange in the city. The exchange is arranged to handle 9000 subscribers and is trunked to all the other exchanges and sub-exchanges in the city. The Adhémar multiple board is used, consisting of jacks in parallel, without test keys, and with indicators that are automatically reset. Each jack consists of two springs for the line circuit and one ring for the test circuit. The plug has three corresponding parts and is attached to a three-conductor flexible cord. The calling and disconnection signals are placed on the upper part of the board behind glass, which protects them from dust and moisture. The arrangement is such that when a jack is plugged the corresponding calling drop disappears and its coil is cut out from the line. This effectually prevents weakening of the talking current by bridging through the drop and also cross-talk due to the mutual inductive actions of the drop coils, which are very close together. The test circuit used to see if a line called for is in use is entirely local, being completely disconnected from the talking circuit, so that there can be no interference with the conversation or "listening in" by the attendant. On the trunking lines to the other exchanges an automatic indicator is used, multiplied at each section of the board and showing the operator which of the various circuits is in use. By this means there is no loss of time in testing the trunk circuits to see which one is free when a connection to another exchange is desired.

Electrical Canal Towage.—The (London) "Electrical Review," in a long editorial on electric haulage in connection with canals, calls attention to some facts that seem equally pertinent to American conditions. The lack of any system of trunk-line canals, the popular interest in railways at the time of their first development, and the fact that the canal interests fell into the hands of railway managers, all contributed as factors to the decay of the British canal system. There is no reason why heavy freight may not be transported cheaply by canal if some reasonable and economical system of towing is adopted. The Thwaite system, now being exploited in Great Britain, consists of an "electric horse," or truck, running on a tramway or aerial structure on the tow path and hauling the boat with a tow line in the time-honored manner. The striking advantage of this method of transporting goods is that there are no grades on a canal. There is no necessity for a motor of large power, as canal speeds can never be high and but a few h.p. are needed to move a great weight of freight. With the electric motor the problem of attendance is solved. The horse requires a driver, but the motor may be controlled from the boat.

The problem of electric canal navigation is an important and promising field for study. While we have not, in this country, the vast network of canals that is a feature of the countries along the North Sea and the British Isles, we have important systems which have, like those in England, fallen into disuse and are too often allowed to go to pieces for lack of proper repair. A system of cheap electric towage would make the canal again a factor of prime industrial importance.

A Long Underground Telegraph Cable.—The following details of what is said to be the longest underground telegraph cable are taken from the "Mechanical Engineer." The cable is now being laid between London and Birmingham, the distance being 105 miles. It consists of 76 copper wires, each insulated with brown paper. The cable is lead encased, its finished diameter being 2½ ins., and is drawn into a 3-in. iron pipe laid about 2½ ft. below the surface of the ground. Sections 450 ft. long are made up, connection between the conductors being made by a small piece of copper tubing fitting neatly over the ends of the wire, which are soldered fast in place in it. At intervals of 5 miles the cable is brought up into a testing box mounted on a cast-iron pillar. These pillars also contain apparatus for pumping chemically dried air into the cable to dry out any moisture that might enter through an imperfection in the lead casing.

It is a pity that some of the main telegraph lines between our great cities are not laid in this substantial fashion. It is safe to say that no "blizzard" will ever interfere with the working of the magnificent line described above.

The Largest Induction Motor.—There was recently completed at Baden what the "Mechanical Engineer" says is the largest induction motor in the world. The machine weighs 27 tons, runs at 544 r.p.m. under full load at 2500 volts and 46 cycles, has ten poles, and gives 1000 brake h.p. The stationary part is the usual ring, mounted upon slide frames. The rotor has its shaft hollowed out at one end for the connectors to pass out to the starting collector rings. Heavy end plates closing the motor can be moved out along tracks to expose the interior for cleaning or repair. The motor will be used to operate a large centrifugal pump to be installed in the municipal pumping plant of the city of Geneva.

The Concourse of Automobiles at Paris.—In the early part of the past summer there was held in Paris a concourse of automobile vehicles under the auspices of the Automobile Club of that city. The various vehicles were given an elaborate series of tests of all sorts and the report of the commission having in charge the experiments has just appeared and been published at length in "Le Génie Civil." It is probably the most important contribution to the literature of motor vehicles, and contains much of interest to electricians. The electric vehicles exhibited bore away the palm, not only for speed and ease of control, but as well for long radius of action and good hill-climbing qualities. The data of the accumulators used goes to show that the French manufacturers are producing storage batteries of excellent performance. The constants of a vehicle of medium class are as follows: The vehicle was a closed coupé seating normally two persons and a driver. Its weight was 3894 lbs., including passengers, of which 81.6 per cent was the weight of the vehicle and accumulators. The batteries were of a seventeen-plate type, the rubber cells being about 5 ins. x 6 ins. x 12 ins. over all, and the forty-four cells carried weighing 1005 lbs. Speeds on level streets ranged from 4.8 to 15.2 miles per hour. On an 8.2 per cent grade the speed was 3.6 miles per hour. The current used in charging the batteries was 300 watt-hours per mile run. This vehicle made a run of 63.55 miles in the streets of Paris over a route containing grades up to 8 per cent with one charge of its batteries.

The Exposition of 1900.—"L'Electricien" publishes the general rules for the installation and exhibition of generating sets, the following being a short summary:

Electricity will be generated by direct-coupled sets only, no belted or other indirectly driven machines being allowed in the generating plant. The administration will consider exhibits of sets or of dynamos and engines separately. Steam will be furnished at a pressure of 142 lbs. (within 10 per cent variation) in the main steam pipes. Electric current must be delivered by the exhibitor at a proper switchboard, which he must supply, at 125, 250 or 500 volts if direct current, or 2200 volts at 50 cycles per second, if single-phase alternating current, Polyphase currents, the same frequency and tension (presumably in each phase). Exhibitors must send in their plans for acceptance by the administration, and must conform to certain rules to insure public safety. The space required is indicated by the administration and furnished free to the exhibitor, who builds his own foundations. At the close of the exposition these foundations may be left in place or removed, at the option of the exhibitor. Exhibitors of engines must make attachments to the steam mains at their own expense, a valve to be provided in each tap near the main header. All the piping for hot and cold water is to be provided by the exhibitor and laid in the conduits provided for it. The general system of conduits is free, but branch conduits to the set are to be built at the expense of the exhibitor. There are special rules concerning the minutiæ of joints, packing, etc. Current is to be delivered at a switchboard containing all proper switches and indi ating apparatus, of designs approved by the administration. Should the latter require it meters are to be provided. The administration buys the current at the terminals of the board from the exhibitor. Those showing alternating and polyphase machinery must provide the necessary transformers for the utilization of the currents supplied by them at places desired by the administration. The sets are to be operated from April 15 to November 5, or 205 days, though the administration may decide to increase or decrease this period by thirty days. Each set will be operated about seven hours per day under a schedule to be promulgated, but exhibitors must be always ready to give the administration the use of their total output.

Water and steam are furnished free to exhibitors, who will also be allowed a sum to partly remunerate them for the expense of construction and a further payment proportional to the number of working hours and normal output of the exhibit. These sums are estimated on the basis of $2.80 per h.p. for sets of less than 1000 h.p.; $1.70 per h.p. up to 1500 h.p., and for larger sets $1.25 per h.p., these payments being intended to go toward the cost of installation. The h.p.-hour rate is: For the first 1000 h.p., 0.3 cent.; for the next 500 h.p., 0.13 cent; for further power, 0.1 cent. At least 500 hours of operation are guaranteed exhibitors. Work is to be begun upon each exhibit by October 15, 1899, and finished before March 15, 1900, when the administration will make tests of all the installations. Failure to be ready at the date fixed is penalized, the dilatory exhibitor having his concession described above reduced, while a delay of a month beyond the opening day renders the exhibit liable to be taken out. Of the total power desired one-half will be generated by apparatus of French manufacture, the other half by exhibitors from other countries. The total appropriated for the payment of the installation costs of the latter is $34,000.

Coherer Action.—Dr. R. Malagoli describes in "L'Elettricitá," some interesting and curious researches into the "coherer action" of powdered metals exposed to electric waves. Arons had already observed that when metallic powders in the field of a microscope are subjected to the action of electric waves minute sparks appear between the particles, but this observation has not been sustained until Dr. Malagoli's work. He made use of a photographic method, covering a narrow space on a photographic plate between two fixed electrodes of sheet metal with a thin layer of powdered metal. A discharge in the neighborhood was followed by the appearance on the plate of dottings that looked like photographs of bacteria—chains and rows of dots. This the author attributes to exceedingly minute sparks leaping from particle to particle of the metal under the influence of the electric waves. He concludes that the drop of resistance in a coherer is always accompanied by this interstitial sparking.

ELECTRICAL WORK DONE FOR SAMPSON'S FLEET BY THE "VULCAN."

When the United States repair ship "Vulcan" was fitted out at the Boston Navy Yard early in June last, it was expected that the electrical installations on board modern men-of-war would be among the very first to make requisitions for repairs. The work was thoroughly anticipated. Every provision was made to meet possible exigencies of the situation off Santiago. Skilled electrical machinists were among her picked crew. Testing instruments and all kinds of electrical stores for marine installations were taken along.

Before the battle of Santiago, and after, electrical work and repairs were executed for the "New York": two searchlights were replaced by new ones, the telephone system was tested for grounds and breaks, armatures of common fan motors were rewound and tested, and other motors were tested for grounds. The only other ship in the engagement for which the "Vulcan" afterward made electrical repairs was the "Indiana," whose small blower motors were overhauled and the armatures of two or them rewound.

Two vessels of the auxiliary fleet, the "Potomac" and the "Manning," called for minor electrical work and repairs to their signal and side lights, electric bells, rewiring of deck distribution and general overhauling of the electrical machinery.

The dynamo fields of the "Vesuvius" were very carefully tested and found to be without fault. When the "Maria Teresa" was brought to Guantanamo Bay for general overhauling by the "Vulcan's" force, previous to being taken north, the dynamos were thoroughly examined and found to be everywhere grounded. No attempt was made to repair them.

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HOW DYNAMOS ARE SOLD.

There is, perhaps, no commercial business so susceptible to ingenious twisting of facts as that which has for its object the sale of electrical apparatus, and this may be well illustrated by the common practice of a good dynamo salesman. Let us suppose, for instance, that we have a capitalist who wishes to install in his office building a 500-light dynamo. Relying on his own business shrewdness, which has stood him in stead for many years, he writes to a number of dynamo builders, and is soon surrounded by their agents, who are anxiously bidding to secure the contract. The various prices are submitted, each agent bidding on the nearest size which he manufactures. If the quality of the machines are equal in every case, the bids will be very close indeed, and in a measure proportional to the size of the machines. The capitalist will review the bids carefully and then talk with each of the representatives upon the merits of the machines in order to make a decision.

The lowest bidder does not need to argue very eloquently. He has the initial advantage, but it is not an infrequent occurrence that the highest bidder can readily carry off the palm. The shrewd agent will soon see that his price is high and will admit as much to his prospective purchaser, but will say: "These other gentlemen are bidding on machines which will carry 500 lights and no more. The machine that I propose to supply you is specially designed to carry an overload of some 50 per cent for four or five hours. The conditions of your load might be such that you will find this an extremely valuable feature. We rate our machines very liberally and allow ample margin for contingencies; for this reason we think we justly ask better prices."

The prospective purchaser will take this matter very much to heart, and the chances are strongly in favor of his buying a 600-light machine disguised under the name of a 500-light machine able to carry overloads. If the agent had said that his machine would carry 600 lights, the buyer would have said, "I do not want 600 lights, 500 lights is ample," but the idea of getting added capacity for practically the same money is most attractive.

Again, we have the case of the purchaser who has pretentions to electrical knowledge. In no case is the old proverb, "A little learning is a dangerous thing," more forcibly illustrated. The chances are ten to one the agent knows about as much of electricity as the purchaser, and the way they exchange high-flown technical terms to their mutual mystification is amusing in the extreme. To illustrate an actual case in point may be mentioned an instance where a certain man had been considering the relative merits of several bids for a dynamo machine for his factory. Some of the agents had been talking knowingly of losses, efficiency, rise of temperature, hysteresis, and other matters relative to the performance of a dynamo. The purchaser gathered that these various quantities were desirable qualities, arguing to himself if these were not such the agents would not have mentioned them, or more probably obtaining his idea from inference rather than argument. When the next bidder appeared and asked for an audience, he proceeded to talk of temperature rise, hysteresis and like matters. The agent likewise, at once inferred that these things were much to be desired in a dynamo. He was of German extraction and he communed within himself, "If Thomas Huston and Edison haf hystersis in their dynamos ve must haf some too." He succeeded, however, in arguing so well that he closed the contract, one of the inducements being that he should write to his firm and stipulate particularly that in the dynamo to fill this order there should be an exceptional amount of hysteresis.

Again, we are told of a case which seems hardly worthy of credence, but is said to be an actual fact, that of two bidders, one making a proposition on an iron machine and the other submitting a price on a machine with a cast steel frame, the former secured the contract, arguing that his machine was the heavier by some 400 pounds, and therefore more substantially built, and was not starved of iron or copper, and there was plenty of material there to stand the load, etc., etc.

A good agent will make talking points out of nothing, advantages out of disadvantages, and virtues out of necessity, and will carry off a contract at a high price, while a man of mediocre business ability with a better machine and scrupulously careful of what he says, will fail to secure the order.

Capitalists do not seem to appreciate cautious, conservative opinions. They must be superlative or they are adverse. Truly said the great showman: "The American public likes to be fooled," and the capitalist most of all. He will not invest his money unless the facts are highly colored, even to misrepresentation.

◆

AMERICAN ELECTRIC RAILWAY APPARATUS ABROAD.

If the advertising columns of our foreign contemporaries is a criterion we have reason to be very much flattered with the commercial success of American electric railway apparatus in England and elsewhere. In the current number of a prominent foreign publication devoted to electric railway interests, some 80 per cent of the advertisements by actual count either exploit American railway specialties distributed through agencies, or are due to local manufacturers who are producing under American patents. Less than 20 per cent of the insertions are entirely free from advertising American railway goods. This speaks more eloquently for American manufacture than any published statement.

It is not surprising, however, that this would be the case in the electric railway field, in which America is the admitted pioneer. We cannot expect a progressive people to begin where their predecessors began, but rather where they are at present. Any newly incorporated industry could not in common prudence do otherwise, and it cannot be expected that foreign countries will continue to use our electric railway apparatus unless we progress, and, what is more, progress faster than they do.

◆

ACCURACY AND PERMANENCY IN SWITCHBOARD INSTRUMENTS.

Modifications of the electrodynamometer have ever been popular in electrical meters, but for some reason it is not so largely used in switchboard work as its great advantage would lead one to expect, preference being seemingly given to types containing permanent magnets or moving iron. For switchboard work a pair of dynamometer coils, with gravity for the restoring force, seems absolutely ideal. There is nothing to change. The same instrument can be used for both alternating and direct currents. It can be manufactured as a voltmeter, ammeter or wattmeter. By the use of air dampers it can be made practically dead beat, and by the ingenious placing of the counterbalance or the employment of several weights successively brought into play, the scale may be made with practically uniform scale divisions. Once calibrated it becomes a standard. Indeed, many standards claim their excellence on account of their employment of this principle. It may further be made very delicate and it is not an expensive construction. Properly constructed there is not a single objection to be recorded against it. An instrument maker properly employing this principle need only excel in workmanship and detail to largely control the market in switchboard instruments.

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The Steam Turbine and the Uni-Polar Dynamo.

The simplicity of the uni-polar dynamo has led many electricians to investigate the possibility of its commercialization. Indeed, this has been so persistently attempted and the problem has seemed so insurmountable that it has become a sort of electrical measles and is closely analogous in its effects upon the engineering fraternity to perpetual motion, its mechanical prototype. The electrical ignis fatuus, however, has the redeeming feature that it is always to a certain extent operative, and the problem is rather to increase its operative efficiency than to demonstrate its possibility.

The current carrying capacity of the unipolar dynamo is enormous. The problem is to increase the voltage, and there are but two ways in which this may be done, the first, that of making a very intense field, and the second, that of increasing the speed. The steam turbine seems to offer unparalleled opportunities in accomplishing the desired result by increasing speed. A 30-h.p. turbine running at 30,000 r.p.m. is a practical possibility, and direct-coupled to a uni-polar disc could produce measurable voltages and current capacity within the limits of the power of the turbine. If we have a disc some 80 ins. in diameter, the effective area which can be fluxed is some 35 sq. ins., through which it ought not to be difficult to thread 35,000 lines of force. If we run such a disc at 30,000 r.p.m. we shall have an effective voltage of 1.75, which is perfectly adaptable for some kinds of plating work. If we increase the diameter of the disc to such dimensions as we can without endangering it from a mechanical standpoint we may raise this voltage to 15 or 20 volts, and by connecting two such machines in series we may attain a voltage of 40 or 50, which is useful for many purposes. If electrical power can be obtained from such simple and cheap apparatus in such quantities, commercial uses will be quickly found for it.

Small Polyphase Stations.

In small country towns, where stations of a few hundred kilowatts capacity will supply the entire demand for electric lighting and power, it is a question whether single or multiphase apparatus is the best suited. In the polyphase station we have the advantage of the possibility of carrying a power load in the day time, but it has been argued by those who favor single-phase machinery that in small stations the motor load will be so minute as to be a positive disadvantage, compelling moderately large generators to run lightly loaded, and that the disadvantage which the necessity of balancing polyphase circuits entails will render the installation of such machinery in such cases very poor engineering.

Where a station is supposed to supply continuous service there is no question that the bigger the load the better, and if the station load were small with the motors, it would be smaller still without them. The problem of balancing the circuits can be very easily solved if the latter are properly planned. Elsewhere in this paper we describe a small installation in which the load in the different circuits can be balanced within an ampere by the simple device of shifting the street circuits from phase to phase, as the conditions may require.

It must not be expected that a good day load will come to any station because it is able to supply it. It must be actively canvassed for and frequently created. There is much missionary work to be done among manufacturers and users of power who are not aware of the advantages to be gained from the use of electric motors. New industries can be induced to locate near power stations if enticing rates are made. Interurban railways frequently thread through towns in which small power stations are operating, and the chances of erecting a small rotary transformer substation to feed nearby sections of the trolley system are almost always exceedingly good; in short, a day load can be acquired if the generating machinery is such as to permit it. If the problem is simply that of meeting an existing load carried on existing circuits, it is undoubtedly true that single-phase machinery would be best, but electric light managers who are content to let their conditions of load remain the same cannot be even called conservative, but are better described by terms which savor strongly of indolence or indifference. The wide-awake progressive manager who is alive to the interests he represents will use polyphase machinery, and by acute and resourceful management and energetic executive ability will create a day load for it. This will make the multiphase station the larger dividend earner in almost every case.

The Candle Power of Lamps for Decorative Purposes.

Incandescent lamps are now very largely used for decorative purposes, particularly for electric signs in the theater district of New York City. In such a case as this efficiency is not particularly to be sought after, for the object of the lamp is not so much to give light to surrounding objects as by its own luminosity to assist in tracing out the name or advertising sentiment so that it will appear brilliantly illuminated at a distance of many hundred yards. It is a fact that if letters of the sign are closely made and brilliantly lighted, that the sign will be less legible than if the lamps were burned at a lower candle-power, for the same reason that the true size and shape of an incandescent lamp filament can be best distinguished when burned at dull red heat. The eye is dazzled by more brilliant light. The outcome of this reasoning seems to be that a sign lamp must be burned at a considerably lower efficiency than one intended for ordinary illuminating purposes, partly because the signs will use less current, and partly because the lamp will be of double or possibly triple life. The true commercial efficiency of the sign lamp cannot be measured in watts per candle-power, for its object is to attract attention rather than to illuminate.

Thickness of Insulation of Magnet Wire.

The rule is given that in shunt magnets the strength of magnetization depends upon the gage of the wire, its specific resistance and the average length of turn, and this latter quantity varies but little with a slight increase of bobbin in diameter and none at all when the bobbin is lengthened along its axis. It is usually assumed that great accuracy is not essential in winding shunt bobbins where there is a single magnetic circuit or where the bobbins are not connected in series. The thickness of the insulation, however, has a great deal to do with the average length of turn. It is a common expedient among makers if the magnetism of a certain coil is not sufficient to rewind with a wire of the same gage and thinner insulation; thus if the same number of turns are retained, and the same gage of wire is used, with equal voltages a single silk covered wire will give a much stronger magnet than a double cotton-covered wire, for the simple reason that there is less copper in the coil and the average turn is reduced. It is a fact that many winders know nothing whatever of electricity, though they may be excellent artisans of their class, and the curious ideas that some of them have are surprising. In this case winders have been known to hold the opinion that the increased power was due to the silk cover, which allowed less electricity to escape than the cheaper cotton covering.

Power Distribution to Long Distance Railroads.

The great problem that must be solved if electricity is to supplant steam on trunk lines is the distribution of power. The polyphase current and the high-tension line, together with the rotary transformer, can take care of ten, twenty, or perhaps fifty miles without trouble, but greater distances than these begin to approach the limits of successful transmission. A multiplicity of power stations will, of course, solve the problem, but at great attendant expense. The policy of stockholders of steam roads has very frequently been such as to direct investment in channels not exactly akin to railroading, such as the acquisition of coal mines, or the traffic in grain or other commodities which are largely transported by freight. It does not seem too much to suppose, therefore, that the projector of an electric trunk line would hesitate very long at investing in an enterprise involving the sale and distribution of electric power in the various localities through which the railroad passes.

If a railroad is to be remunerative, it must pass through the principal towns that lie between its termini, even at the expense of a considerable divergence from the straight line connecting them. In each of these towns there is a market for more or less power, and in the principal ones could be installed a power house of sufficient dimensions to take care of a section of the railroad, to distribute to sub-stations at intermediate distances and to supply electric current for power, light and the propulsion of the local electric railroad system. It is the large station which reduces the cost per k.w.-hour. Large engines and boilers and large generating units reduce attendance and repair and increase efficiency. The alternate current system enables the introduction of an installation to supply all kinds of service.

Consider the problem of an interurban road 100 miles in length, passing through six or eight small towns of, say, about five or ten thousand inhabitants, and three or four large ones, of from fifty to one hundred thousand inhabitants. Two stations with an appropriate number of sub-stations would be sufficient to equip this road electrically. These stations should be located in or near the larger cities and the sub-stations distributed in the smaller ones. The power house would generate high-tension alternate currents for distribution to the sub-stations, 750-volt current for the trunk line, 500-volt current for the local street railway systems, and 110 to 220-volt alternating current for power and light. This service would be duplicated in so far as possible in the sub-stations, the idea being to secure for the station a diversified load and a very even load curve. The commercial advantages of this arrangement are apparent. The enormous station generates the power very economically, and the competition of the local light and power companies can be carried to so low a figure as to compel consolidation. In small towns in which the rotary transformer sub-stations were located, power and light could be supplied at a profit in quantities so small that an ordinary lighting plant could not possibly subsist on the income. Short street railways could be installed in the smaller towns and be made to pay. In this way the sub-stations which, if they depended for their load on the trunk line alone, would run idly for long periods, would have a paying load at all times, thus doing away with the principal commercial objection, that of a multiplicity of lightly loaded stations.

The gigantic dimensions of such an enterprise, applied to a large trunk line, are appalling, not so much on account of the enormous size of the stations as on account of the fact that such a combination of capital would be a trust of immense power, and also because, however improbable the development of such an enterprise may be, it is not impossible, and would tend to disturb the social conditions in the country to an even greater extent than they are at present in these times of strikes and trades unions.

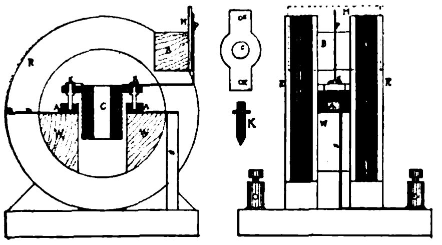
Should the Dynamo Frame Be Grounded or Insulated?

It is a much discussed question between American and English engineers as to whether it is advisable to insulate a dynamo frame from the earth or to thoroughly ground it. With machines whose maximum voltage does not exceed 125 it makes little difference, in the case of isolated plants. Where the output of the machine is distributed over outdoor wiring, the danger of destruction by lightning is greatly enhanced by grounding a dynamo. A high voltage machine with a grounded frame increases the danger of burn-outs in case of a ground somewhere on the line, but if the machine is additionally insulated this danger may be practically eliminated. Indeed, in some three-phase machinery connected on the Y plan it has been suggested and even practiced to connect the wire from the common junction of the winding to the ground. If this is done there would certainly be no added danger in grounding the field frames themselves. On the other hand, the element of safety to attendants, if taken into consideration, forms the basis for a strong argument in favor of grounding the machine frame. It is obvious that if this is done the danger of shock to the attendant is very much reduced, because the ground on which he stands is of the same potential as the machine frame which he has occasion to handle. If the welfare of the machine only is to be considered, by all means it should be insulated as well as possible from its foundation, but if safety for the attendants is the desideratum, the winding of the machine should be better insulated and the field frame itself securely grounded.

SIMPLE VOLT-, AMPERE-, AND WATTMETERS.

BY CHARLES T. CHILD.

The instrument shown in Figs. 1 and 2 belongs to the moving coil type and is adapted to either alternating or direct currents. On a wooden base are mounted two wooden rings, R R, about 6 ins. in diameter, upon which are wound about 20 turns of No. 10 wire. The blocks W and W carry on their upper surfaces small copper cups, A and A_1, which are soldered to the copper strips m and n and so connected that the current circulating in the coils R R includes in its circuit the two cups and the coil C, which is suspended between them. This coil is wound on a thin hardwood frame of the shape shown in the drawings, the upper of the two small drawings showing its upper surface. The coil has 20 turns of No. 10 wire, its ends being soldered to the copper pins K K. One of these is shown on a larger scale in the small drawings. At their bottoms they are filed into knife-edges, so that when they are placed in the copper cups, A and A_1, the coil C rocks on them. The bottoms of the copper cups are slightly hollowed to keep these knife-edges in place at the center, and the whole system is balanced so that it rocks very easily on the knife edges. The cups A and A_1 are filled about half full of mercury, on the top of which is placed a drop of kerosene, or, better, of a mixture of about 4 parts of kerosene and 1 of alcohol in which is dissolved 5 per cent of cyanide of potash. This preserves the mercury surface from oxidation and also relieves the surface tension. A pointer, P, is attached to the rocking coil and plays in front of a scale as shown. The instrument should be covered with a bell-glass, or a wooden box having a glass front, to keep out dust and air currents.



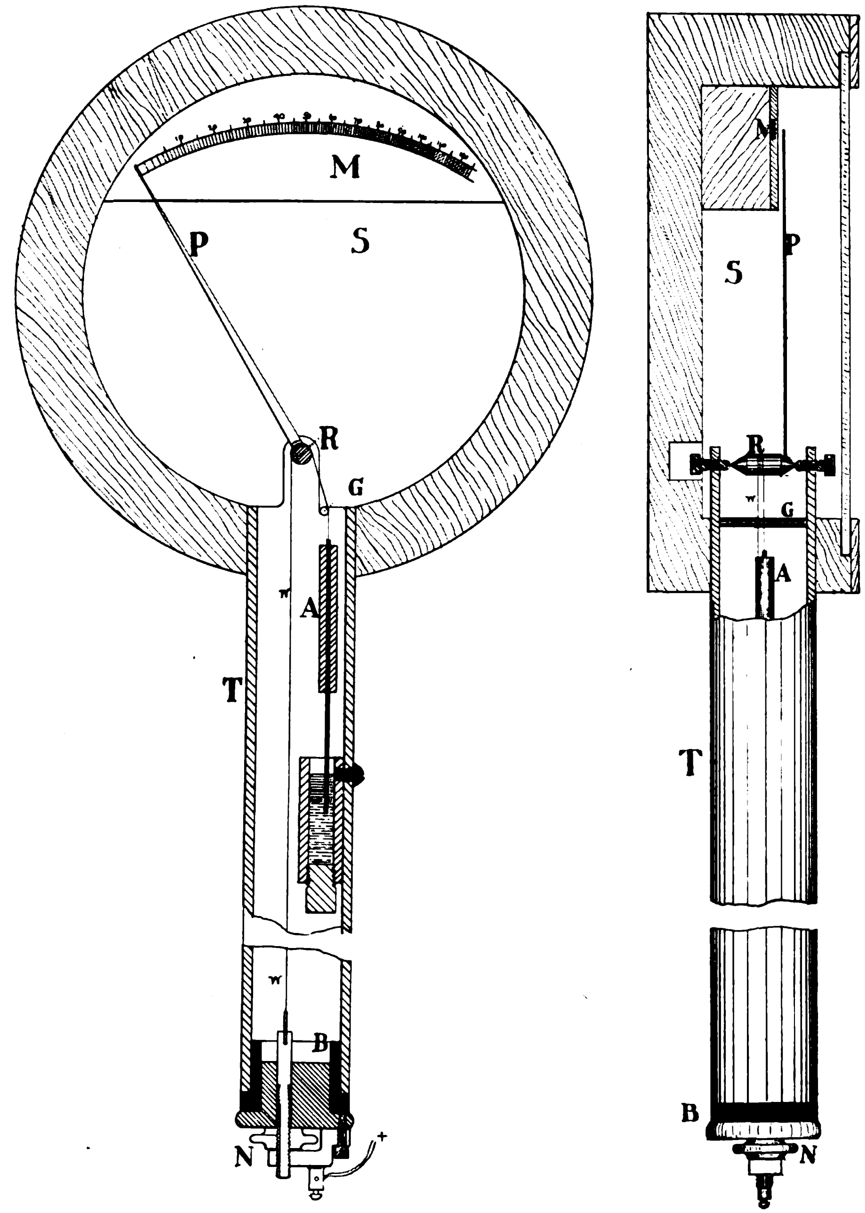
FIGS. 1 AND 2.—ALTERNATING AMMETER.

While this is by no means an ideal instrument it is a satisfactory one for many purposes. It should be mounted on a shelf on a wall or in some other place where it will not be disturbed or subject to vibrations, and it should be taken down and cleaned occasionally. The nearer the knife-edges come to the center of gravity of the suspended system the more sensitive the instrument will be. It is advisable to make the coil, C, as light as possible, and for this reason aluminum wire should be used in place of copper for winding it if this can be obtained. This instrument is not "dead beat," but it has a fairly constant scale through a range of about 30 degs., which is a great advantage.

For alternating current work the "hot-wire" instruments possess some important advantages, among them that of not affecting the circuit in any way, as the coil instruments do by their self-induction. The instrument next to be described is somewhat similar to the Cardew hot-wire voltmeter, and, while rather delicate, is an excellent instrument in careful hands.

The principle upon which it depends is the expansion of a small wire heated by the current to be measured. A wooden box, 8 ins. in diameter, is turned to form the head of the instrument, and to this is attached as shown a piece of iron gas-pipe, T, 1¼ ins. inside diameter and about 3 ft. long. At the bottom of this pipe (the instrument is intended to be attached to a wall with the wooden box part uppermost) is a brass plug, insulated from the pipe by an insulating bushing, B, and carrying a threaded rod and nut, N. This threaded rod is grooved, a small pin engaging in the groove so that when the nut, N, is turned the rod is screwed in or out, but does not turn around. There should not be the least lost motion about this fitting, as the motion of the threaded rod must be accurate and exact. In the upper extremity of the threaded rod is soldered a small bit of copper wire split at its upper end. This is to clamp the platinum wire, w, whose expansion is recorded by the instrument.

At the upper end of the tube, T, is arranged a small drum, R, having coned ends resting in the screws as shown, or the screws may be pointed and the drum coned out for their reception. The drum should be not more than 3-16 in. in diameter, and is best made of steel. It is shown relatively too large in the illustrations. Around this drum the platinum wire, w, is wrapped two or three times, the surface of the drum being first enameled with a mixture of finely powdered asbestos and water-glass (soda silicate) painted on and dried with gentle heat. It is not absolutely necessary to enamel the surface, but it is well to do so, as this prevents any current from flowing through the cone bearings of the drum and heating them.



FIGS. 3 AND 4.—HOT WIRE AMMETER.

In the tube, T, is secured a small piece of ½-in. iron pipe, closed at the bottom with a plug, and partly filled with mercury. The platinum wire, after passing around the drum, is deflected by the glass rod, G, so that the wire attached to the weight, A, suspended from the platinum wire, dips in the mercury. This wire should be of copper and the weight should be of lead or brass, its weight depending upon the size of the platinum wire, but enough to keep it taut. For a No. 38 platinum wire the weight should be about 1½ ozs.

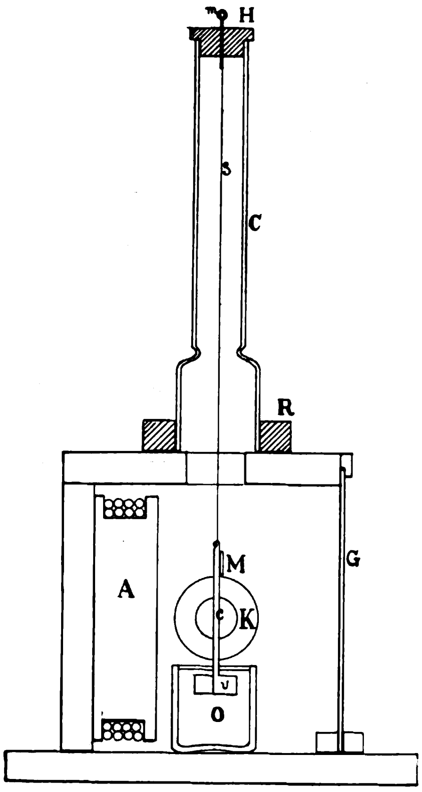


FIG. 5.—SIDE ELEVATION, WATTMETER.

A resistance is absolutely necessary with this type of voltmeter, and the otherwise empty space, S, will contain it comfortably. For voltages up to 150 a resistance of about 4000 ohms should be used and the platinum wire should be about No. 38 or 40. The resistance can be wound on a wooden spool and is best of German silver wire, about No. 32, preferably not smaller.

As the expansion of the iron pipe and the platinum wire are not the same, the daily changes of temperature, the stretch of the fine wire, etc., will make the zero point somewhat uncertain. For this reason the nut, N, and its adjuncts are provided, so that the needle can always be adjusted to zero before the reading is made. The instrument is quite sensitive, absolutely dead-beat, and entirely unaffected by external magnetism. The best way to increase its accuracy without making it more delicate is to lengthen the pipe, T, but this has practical disadvantages. It should be mounted by means of wooden cleats against a wall and left there. Care should be taken in winding the resistance coil not to make it inductive, as this will vitiate the accuracy of the instrument and introduce complications in the circuit. To wind the resistance non-inductively two wires should be wound at once on the spool, and then connected together so that the current circulates in different directions through each.

A sensitive and excellent wattmeter may be very simply made as follows: On a wooden base build up with brass screws or glue a wooden box, as shown in Figs. 5 and 6, about 7 ins. x 8 ins., and 7½ ins. high, having a glass front, G. Against the back of this box is mounted a wooden spool, A, carrying a coil of a few turns of coarse wire. For currents up to about 20 amperes No. 8 wire and 8 or 10 turns are advisable. In the center of the top of the box is cut a hole, and mounted above this in a wooden ring, R, is an ordinary glass lamp-chimney of the shape shown (such as is used with "student lamps"). In the top of this is a plug, H, fitting so that it can be turned with the fingers, and carrying two wires, m, n, fitting rather tightly in the fibre or wooden plug. If wood is used it should be boiled in paraffine, as the voltage measured is in full force between the two pins, m and n. These pins should be 1½ in. apart, and should be split at the bottom so that the two thin suspension wires, S and S, may be pinched in the split part.

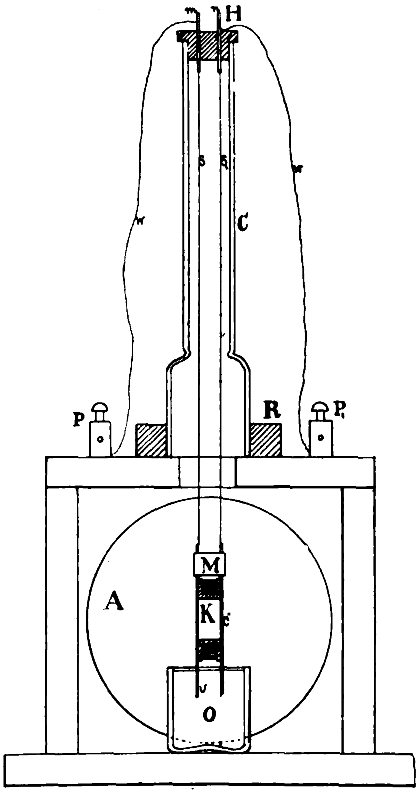


FIG. 6.—END ELEVATION, WATTMETER.

Suspended from these two wires is the coil of fine wire, K. This is wound on a fibre spool, 2 ins. outside diameter, 1 in. inside diameter and having a space for the winding ½ in. wide measured along the axis of the spool. It should be as thin as possible to reduce its weight, and should contain about 300 turns of No. 32 wire. In winding this the greatest care should be used to insulate it thoroughly, and the wire should be copiously shellacked and the coil thoroughly baked after completion. The ends of this coil are connected to the two thin sheet copper or aluminum strips, c, which are shellacked to the sides of the spool. At the lower end of each of these strips is a vane or projection, v, the two being arranged to point in opposite directions. These are intended to dip into kerosene oil contained in the cup, O, and to dampen the swinging of the suspended coil. Across the two strips, c, is fastened with gummy shellac a small mirror, M, best made by silvering the surface of a bit of glass such as is used for microscope slide covers, though a piece of ordinary thin looking-glass will answer. The two suspension wires, which should be of exactly equal length, are fastened to the strips, c, with small drops of solder. These suspension wires should be of copper, not larger than No. 36 gauge and preferably smaller. It is not necessary to remove the insulation from them.

Two binding posts, P and P₁, are provided for attaching the fine wires, w, leading from the pins m and n. To these posts are connected the terminals from the two sides of the circuit to be measured, while the main current is led through the coil A. The deflections of the swinging coil are read off by means of a lamp and scale, a simple and excellent arrangement for this purpose having been described by Mr. J. M. Hobart in "The American Electrician" for February, 1898, in an article entitled "A Sensitive Mirror Galvanometer." For small deflections the scale readings are proportional to the watts. This instrument is equally good for alternating and direct current work, and in careful hands is surprisingly accurate. It is quite good enough for incandescent lamp measurements.

Of course, a resistance must be used in series with the fine coil, the amount being proportional to the voltage of the circuit. Up to 150 volts, using No. 32 wire on the coil, the resistance should be about 2500 ohms, and it should be wound non-inductively as described above. If very accurate determinations are to be made the self-induction of the fine wire circuit may be compensated by a condenser consisting of a glass plate with a strip of tin-foil on each side, but this is an unnecessary refinement for ordinary work.

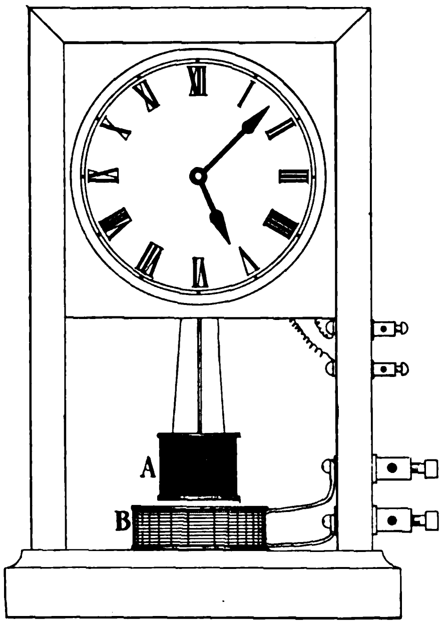


FIG. 7.—RECORDING WATTMETER.

A watt-hour meter may be made from any pendulum clock, a good one being, of course, preferable. The arrangement is shown in Fig. 7. The bob of the pendulum is replaced by a fine wire coil of many turns, small wires being led up to points near the center of motion of the pendulum and thence to the binding posts on the case. Below the pendulum and as near it as possible is a coarse wire coil, B. The main current flows through this while the fine wire swinging coil is bridged across the circuit. The clock is first adjusted carefully to keep correct time with no current in the coils. The mutual attraction between the coils causes either an acceleration or retardation of the rate of the clock in proportion to the watts passing, and all that is necessary is to know the constant of the apparatus and note the gain or loss of the clock. Up to a gain or loss of about 3 minutes per hour this meter is very accurate. Of course, to get the constant it is necessary to calibrate the meter by working it for several hours on a known load. It is equally applicable to direct or alternating currents.

On a constant pressure supply system, direct current, the swinging coil may be replaced by a bar magnet, and the instrument then becomes a coulomb-hour meter, or, if the voltage is constant, a watt-hour meter. The well known Aron meter, much used in England, is constructed on this principle.

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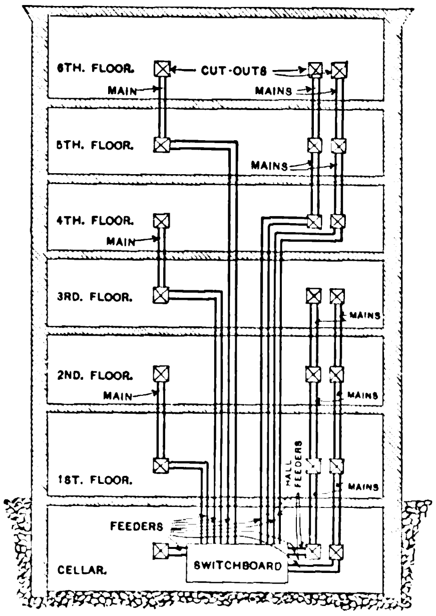
INTERIOR WIRING.

BY CHARLES E. KNOX.

FEEDERS AND MAINS.

The control of hall or night lights from the main switchboard is one of the most important points to be considered in the arrangement of the feeder system.

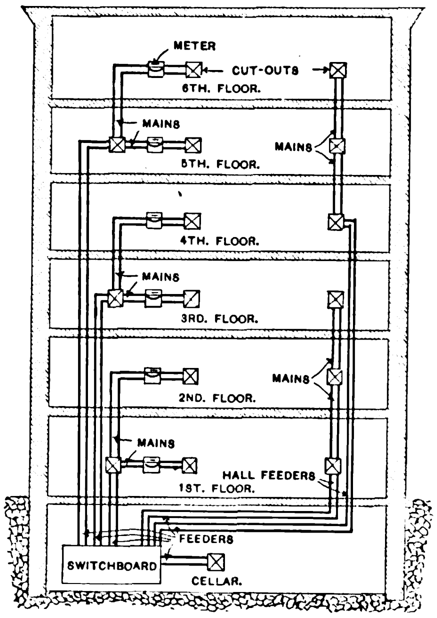


Am.Elec.

FIG. 1.—ARRANGEMENT WITH SEPARATE HALL FEEDERS.

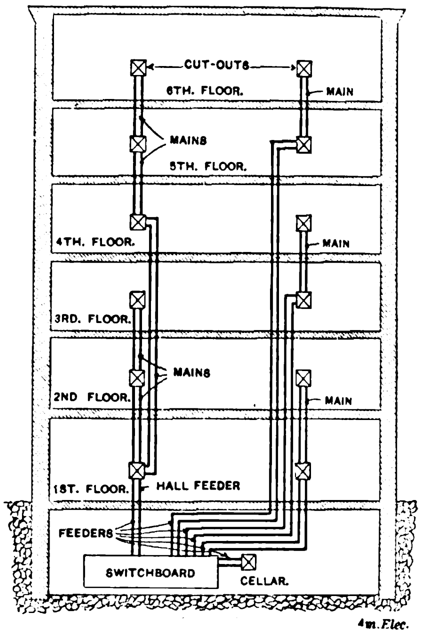
In a private dwelling house it would hardly pay to have a separate feeder for the hall lights, as these lights are generally few in number and could readily be controlled by a few local switches, more readily, in fact, than by a feeder switch at the main switchboard. It may not be necessary even in a hotel, where there are attendants continually passing through the hall who could control the lights, either by local switches or by switches at the distributing center. It is questionable, however, whether it would be as economical to allow the average hotel attendant to use his judgment in putting on the hall lights, as it would to have them turned on at the proper times by the switchboard operator.

In the majority of public buildings, however, the advantages of having separate feeders for the hall lights are so obvious that the problem is generally not whether there shall be separate feeders for the hall lights or not, but whether there shall be one or two sets of hall feeders. By having two sets of feeders for the hall lights, local switches for them may be dispensed with and they may be controlled entirely by the main switchboard. Of course, having two sets of hall feeders increases the cost of the wiring installation and makes the system more complex, but its possibilities for saving current are considerable. In a large building having long corridors, one set of hall feeders would not be sufficient unless the lights were also controlled locally at each floor. During a large part of the day some light may be needed in the hall, but a small portion of the whole number would be ample. With but one set of feeders it would be necessary for the electrician to close the hall feeder switches and then to go through the halls and turn those lights off which were not needed; when it became time for all the lights to be turned on, it would be necessary for him to make a second trip to turn them on again. By having two sets of feeders, one set supplying, say, one-third of the hall lights, and the other set supplying the remaining two-thirds, this control would be entirely from the switchboard and would undoubtedly result in a saving of current. The lights controlled by the feeder supplying one-third of the whole number would also serve for an all-night circuit (for a watchman) in case this was necessary. Where there are two sets of hall lights thus controlled, the wiring of the outlets should be such as to give a uniform distribution of light when either set of lights were burning. Fig. 2 shows a typical case of a business building with two sets of hall feeders. This arrangement very nearly corresponds (on a smaller scale) to the arrangement of the feeder system in a New York City building. As a rule, a saving of current would usually result from having two sets of hall feeders in a building over five or six stories, having more than six or eight hall lights on a floor.



Am.Elec.

FIG. 2.—ARRANGEMENT WHERE TENANTS ARE SEPARATELY METERED.



Am.Elec.

FIG. 3.—ARRANGEMENT FOR FACTORY BUILDINGS.

Where a building receives its current supply from an outside source, the tenants paying for the current consumed (as measured by a meter), a separate feeder for the hall lights is indispensable, as the hall lights of course should be paid for by the owner of the building. Fig. 3 shows an arrangement of feeders in such a building, where each floor or loft may be rented to a separate tenant. It will be noted that here the meters are located on each floor instead of at the switchboard. Where a building is not of sufficient size to require a separate feeder for each floor, this is a much more economical arrangement than having them placed on the switchboard, as two or more floors may be fed by the same feeder. It is sometimes a difficult matter to find a suitable place to locate the meters on the various floors, but it has the advantage that the tenant can take his own meter readings as a check on the lighting company's inspector.

Fig. 4 is an example of a factory building where a watchman is employed to make the "rounds" of the building at certain periods. Of course, light must be left on the stairs and hallways for this purpose, but it is required nowhere else. By having a separate feeder for the halls, the current may be cut off from the lofts at the switchboard, thus saving any current consumed by lamps that may have been left lighted by the employees when leaving the building.

3. Maximum number of lights should be controlled by one feeder.

"Mark Twain" says he believes it is the best plan to put all your eggs in one basket and then "watch that basket." This would not be a good maxim to adopt in arranging your feeder system.

It very frequently happens that an engineer will be caught with one machine running almost up to its maximum capacity when a sudden rapidly rising load is seen to be coming on. Now if all the lights are supplied through a few heavy feeders, he may have to take his chances on getting a second machine running and up to voltage before his circuit breaker throws out or a fuse blows. If, however, there are more feeders supplying fewer lights, he might be able to select one or two that might be cut off the board if necessary until he got another machine "up to voltage." Then, again, a short circuit might occur which would go past the fuses in the main distributing boards and throw the feeder circuit breaker out or blow its fuse. The greater the number of lights on this feeder the greater would be the "area of disturbance."

It would be impossible to give any rule as to the limit in the number of lights that it is best to supply through one feeder, as this will vary under different circumstances. The total number of lights in the building, the available space for the switchboard, the method of control desired, and the cost, would all tend to influence this consideration.

4. Best maximum limit for the size of feeder conductors.

Two variables influence the size of the feeder conductors, the number of lights supplied and the loss allowed.

As a rule, when the number of lights is the only factor determining the size of the wire, i. e., when the distance is so short that the loss desired would call for a smaller size of wire than the current carrying capacity would allow, it is best to limit the number of lights to the neighborhood of 400 (about 190 amperes). One reason for this is that this load is the limit allowed for a 4/0 B. & S. wire, which is the largest size of wire that can readily be installed in an inch and one-quarter conduit, and when the use of a larger size of conduit may conveniently be avoided it is well to do so. Where the conduits are to be run concealed under the floors, it is generally difficult to find suitable runs for larger sizes than this.

Also for the reasons noted under the previous heading (maximum number of lights that should be controlled by one feeder) this number of lights would tend to be a limit.

Where, however, the number of lights is not alone the determining factor, but where the loss also has to be considered (which is true in the great majority of cases), we frequently have to use larger sizes of wire for the feeders.

5. Portion of total loss allowed in the feeders and mains.

As stated in a previous article, the loss usually allowed in the branch circuits is one volt. Where the total loss (from the switchboard to the lamp) is four volts, this leaves three volts to be distributed between the feeders and the mains. Where the total loss is three volts, two volts is divided between the feeders and mains. In any case, it is best to allow most of this loss in the feeders, as this tends to minimize the difference in voltage between lamps supplied by the same feeder. As a rule, the best results are obtained by having two-thirds of the remaining loss in the feeder, and one-third in the mains. In the case of four volts total loss, this would mean two volts loss in the feeders and one in the mains and one in the branch circuits. Where the total loss was three volts there would be a volt and one-third in the feeders, two-thirds of a volt in the mains, and one in the branch circuit. Where the total loss was more or less the same ratio might hold good.

AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

PROTECTIVE DEVICES.

Another device somewhat similar to this, but adapted to open the circuit instead of connecting it with the ground, is shown in Figs. 1, 2, 3, 4 and 5. This is an invention of Mr. F. R. McBerty of the Western Electric Company, Chicago. The construction of the coil itself is best illustrated in Fig. 12, in which b is a small hollow rivet of conducting material, upon which the coil a of German silver wire is wound. One end of this coil is attached to the shank of the rivet, as shown, and the other end to a metallic plug or button f. The hook c is soldered into the hollow rivet b, and the whole is inclosed in a hard rubber bushing d, as is clearly shown in Fig. 13. A hard rubber plug e is forced into the cavity in the bushing after the rivet has been put in place, and this serves to insulate the head of the rivet from the metallic plug f. A forked standard g is mounted, as shown in Figs. 9, 10 and 11, so as to form a support for the heat coil when in place. A leaf spring i, insulated from the support, forms one terminal of the line and presses firmly against the plug f. The hook c of the heat coil is engaged by a spring l, which is held thereby under a considerable tension. This spring forms the terminal of the instrument wire, so that the circuit from the line passes through the spring i, the plug f, the coil a, the hook c, and the spring l to the instrument. When a current of sufficient strength to melt the solder passes through the coil, the plug c is pulled out and the spring l is thus allowed to assume its normal position. This produces a wide opening in the line, so as to prevent arcing across the gap.

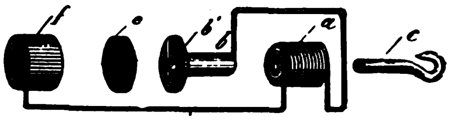


FIG. 4.—DETAIL OF MCBERTY'S ARRESTER.

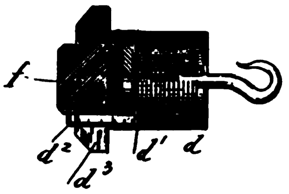
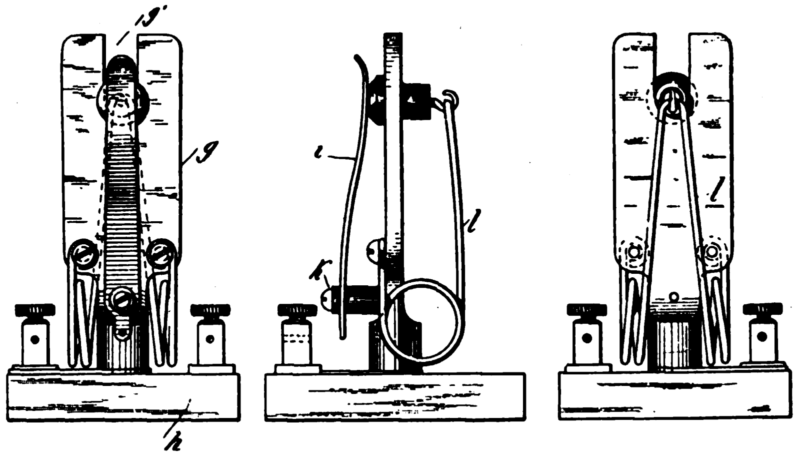


FIG. 5.—DETAIL OF MCBERTY'S ARRESTER.



FIGS. 1, 2 AND 3.—MCBERTY'S THERMAL ARRESTER.

Heat coils may be so adjusted as to be operated by extremely small currents, and they show great uniformity in their operation. By varying the length of the resistance wire or its size, they may be made to respond to a given current in almost any length of time desired. The times of operation for coils constructed in the same manner will not vary over 1 per cent from each other. These coils are usually adjusted to act when subjected to a current of one-quarter ampere for thirty seconds; they are, however, sometimes adjusted for currents as low as .15 ampere. In later coils about 30 ins. of No. 31 B. & S. German silver wire is used. Heat coils of types similar to these are now built in several different forms and are generally combined with carbon arresters. In protecting switchboards, it is of the utmost

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importance that arresters be provided for each side of each drop and, as economy of space is a very important item in telephone exchanges, it becomes necessary to arrange them in as compact a manner as possible. Fig. 14 shows combined carbon arresters and heat coils mounted on long strips of iron for this purpose. The principles of operation are the same as those already described, although the structural details are somewhat different. The line wire enters at spring D and thence passes to spring F, through the heat coil B to the spring G and thence to the switchboard wire through terminal E. The spring F rests in a groove of the carbon block A, which is separated from a similar block by a small strip of mica, shown in detail at the right-hand portion of this figure. This second block rests on a ground plate. An added feature of protection is provided by inserting in one of these carbon blocks a small drop of fusible metal. If an arc occurs between the two blocks, this metal will melt, thus establishing a perfect connection between the two, and grounding the line. In case, however, a smaller current comes in over the line, it operates the heat coil and allows the central rod, which is of metal, in this case, to press the light spring attached to the lower side of F into connection with the ground plate. The other side of the line is connected to the other side of the switchboard coil in the same manner; the line entering at the terminal C, passes by means of an insulated bolt through the iron frame on which the apparatus is placed, to and through the corresponding heat coil on the lower side of the plate. It passes to the switchboard wire by the terminal E.

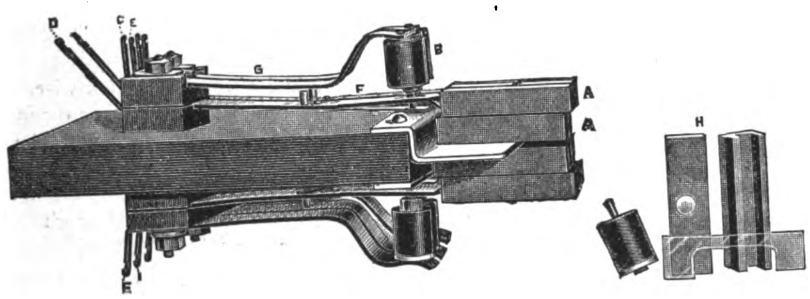

FIG. 6.—COMBINED CARBON AND HEAT COIL ARRESTER.

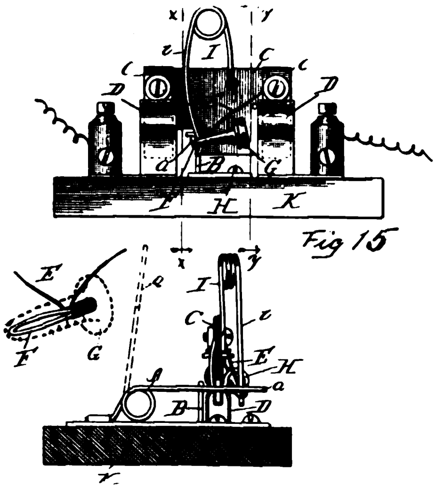

FIG. 7.—ROLFE THERMAL ARRESTER.

Still another type of arrester which is coming into increasing use among the independent companies is that shown in Figs. 15 and 16. In this, which is the invention of Mr. C. A. Rolfe, of Chicago, the two binding posts which are connected respectively to the clips D and D', form the terminals of the line wire, and of the wire leading to the instrument to be protected. On an insulating strip C, usually of fibre, are provided the metal ends c, which are adapted to be held firmly between the clips D and D'. A fine wire coil E of German silver is connected between the metal end pieces c, being attached thereto by small screws and washers. The coil E is imbedded in a mass G of some easily fusible substance resembling plumbers' wax; the smaller portion of which extends through an eye H on the plate C. Said eye is arranged to support G and to provide a stop against which the head of the button is normally held by the tension of a spring I, secured to the upper portion of the plate C, as shown. A is a coiled spring mounted upon the base K, and provided with an arm a, which may be held by a catch B. The relative position of the springs I and A are such that, if the spring I is released, it will strike the arm a of the spring A and cause it to disengage the catch B. The spring A will then, in its attempt to rise, as indicated in the dotted portion of Fig. 16, strike the under side of the plate C and lift it entirely out of the clips D and D'. As the coil E forms a part of the circuit, a current in excess of that which it is adapted to carry will develop enough heat to melt the wax, and this will allow the head of the coil to pull through the ring H. This in itself usually breaks the wire E, and thereby opens the circuit; but, as an additional protection, the spring A gives a violent kick, which is sufficient to throw the entire plate C and its mechanism high into the air. This affords a very effective break between the line terminals, so much so, that it is almost impossible for an arc to form. This arrester is sometimes termed the grasshopper cut-out, on account of its peculiar action.

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A SERIES ARC HINT.

Station managers are now placing as many series arc lamps on their lines as the insulation will stand. In long street lines, such as boulevards and the like, two machines, one at either end of the line, with an equal number of lamps on each connecting leg, will cut the maximum voltage in two.

STEAM ENGINE PISTONS.

BY JAMES F. HOBART, M. E.

The earliest form of piston was undoubtedly a piece of iron with a groove turned in the edge and filled with rope or twine, in much the same manner that the boy of today makes tight the plunger of a squirt gun by winding twine around it.

An improvement was soon found necessary, and the piston head was made in two pieces, one part being so arranged that it could be screwed down on the packing, as the latter wore out, in much the same manner as far as screwing down is concerned as the gland on a valve stem is screwed home when the packing lets steam leak past it.

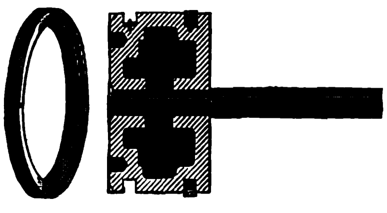

FIG. 1.—PLAIN SNAP RING PISTON.

For many years fibrous packing was used with never ceasing annoyance from leakage. Finally some person to whom no monument has yet been erected made a ring packing and the problem was solved.

Fig. 1 shows a structure of this kind. It is hollow to secure ample wearing surface without excessive weight to cause needless friction. The rings are made eccentric and are fitted with dowel pins in the grooves to prevent the rotation of the rings upon the piston. The rod and head are forced together, the former being shouldered and riveted on either side of the piston head, so there is no danger of its coming off through the loosening of bolts, etc.

The two holes in top end of piston are for the purpose of screwing the rod into the crosshead, a wrench being furnished to fit them.

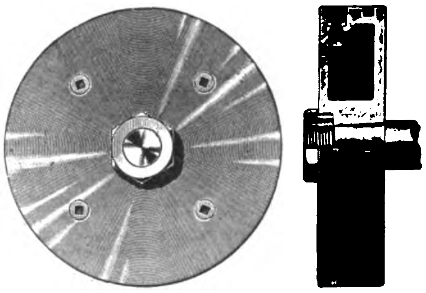

FIG. 2.—SOLID PISTON RINGS, SPRING ADJUSTED.

Fig. 2 shows another form of one-piece, or "solid" piston, for all that it is cast hollow, and the four plugs noticed in the end elevation are for closing the cavity so as to prevent the ingress of steam or water.

The peculiarity of this piston is in the manner of adjusting the rings. Instead of being sprung into the grooves in the piston, the rings are cut into sections and a spring placed between the ends of each adjacent section. The engraving plainly shows the manner in which the rings are forced out by the spiral springs which bear against the oval connecting pieces.

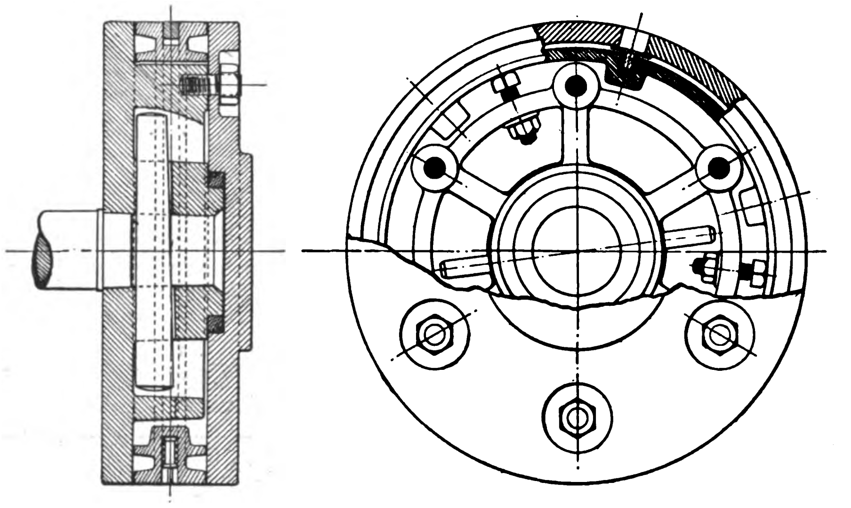

FIG. 3.—SPRING EXPANDED RINGS, WITH SCREW ADJUSTMENT.

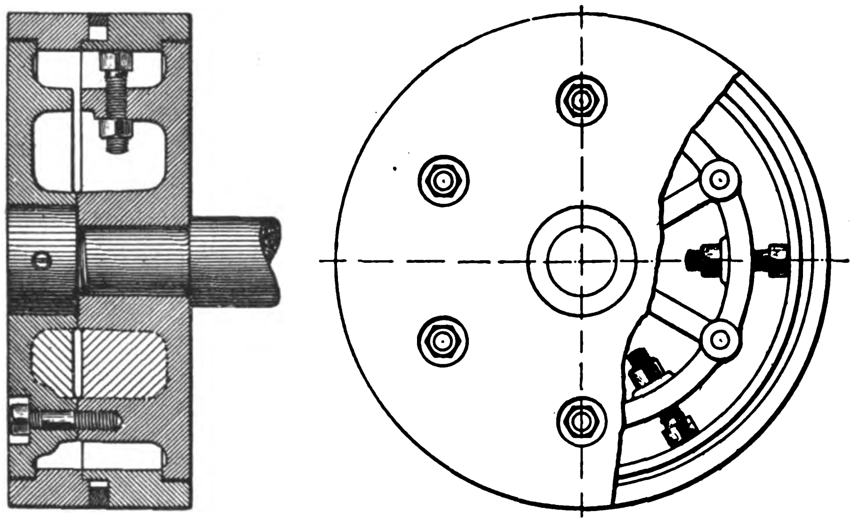

FIG. 4.—DOUBLE BULL RING PISTON.

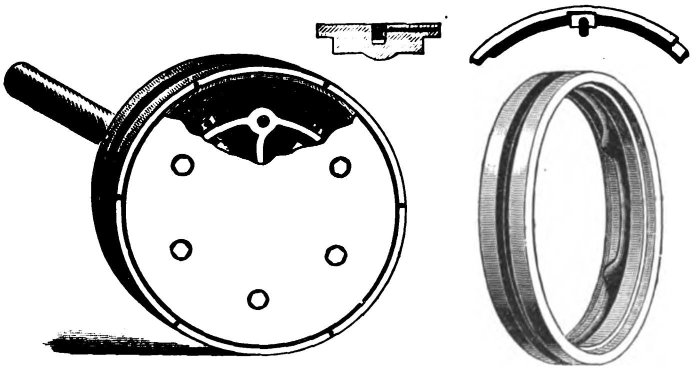

FIG. 5.—BABBITT & HARRIS PISTON PACKING.

Another similar form of piston, shown by Fig. 3, also has the spiral spring ring expansion, in addition to which the ring itself is placed in another ring, which is adjustable by means of screws inside the piston, so that the latter may be centered inside of the cylinder. These rings are made steam-tight by means of bronze "keepers" and the coiled springs are of German silver. The head is pressed on to the rod, which is riveted and keyed, thus making it impossible for the head to come off accidentally.

A somewhat similar form is illustrated by Fig. 4, but here the front or head end of the piston is flush, and needs very little clearance room. The rod is forced into the body of the piston, then a nut is screwed on and dowelled, after which the follower is put on and bolted. There is also a screw adjustment for centering the piston in the cylinder. This piston is made with only one packing ring, for the reason that its builders do not believe in two rings. It will be noted that in this piston the steam ring does not need to be sprung into its place, as by taking off the follower and one-half of the bull-ring, the rings can be slipped in or taken out at will. This is a point to be appreciated by those who have "monkeyed" with a stiff ring and a screw driver, even to the point of profanity.

Fig. 5 shows another form of single ring piston packing, but with a sectional ring automatically expanded by German silver springs. The three cuts in engraving No. 5, show clearly the manner in which the rings are placed in a loose one-piece bull-ring, which has centering adjustments.

A somewhat similar construction, but with two rings instead of one, is the subject of Fig. 6. Here the coiled spring is used, and the rings are made sectional, the springs being placed under the ends of the spring sections. This piston is fastened to the rod by jam nuts, which are let through the follower and bear directly against the body of the piston, through which the rod has been forced. It will be noticed that this piston has its edges chamfered off where it comes opposite the ports. The reason is obvious, but it necessitates placing the piston in a certain position at all times, and if it be rotated by accident or design steam cannot enter freely until after the commencement of the stroke. Several times a card showing very bad initial pressure has been traced to this cause.

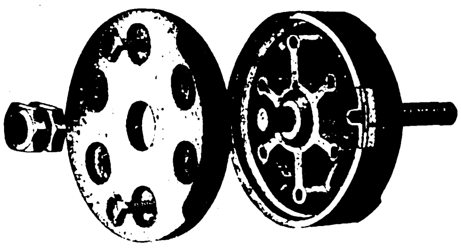

FIG. 6.—DOUBLE PACKING RINGS.

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Lessons in Practical Electricity

HOW TO DESIGN A DYNAMO.

In the last three articles we succeeded in determining, approximately, the dimensions of a 100-light dynamo. We must now go over our calculations with a view to accurately determining the size of the field coils and the wire with which they shall be wound.

The duty of shunt bobbins is to provide a field which will produce in the armature a voltage equal to the voltage of consumption; that is to say, the voltage at the lamp socket and other translating devices. The duty of the series bobbin is to generate additional voltage to make up for the drop in the armature at full load, the loss in the lines, and the loss of voltage due to armature reaction. The first two of these latter quantities can be accurately calculated, the third only approximately.

The shunt bobbin being the simplest will be taken up first. It should produce a flux of force sufficient to make the armature generate 110 volts, and with an armature carrying 168 conductors and revolving at 1500 r.p.m. it must force through it 2,619,046 useful lines. If further we assume a loss in leakage of ~~60 per cent,~~ as we have assumed, the amount forced through the

61.6

field frame must be ~~60 per cent~~ 1.6 more, or 4,190,474 lines.

To find the necessary ampere turns to force a given number of lines through a given mass of metal, air or other material, we must multiply that number of lines by the length of the path through which they are to be forced and divide that result by the area of the path and by the permeability of the substance at that density of magnetization. If these dimensions were measured in centimeters, the product obtained would be the magneto-motive force in gilberts. To reduce it to ampere turns it must be divided by 4π divided by 10, but as in this case we are not using metric measures, we must multiply by a suitable constant to reduce to English measures and .3132 is such a constant. The formula then becomes:

$$\text{Ampere turns} = \frac{\text{N} l \,.3132}{a\mu}$$

where N equals the number of lines of force, l the length of the path, a its area, and μ its permeability.

We will first apply the formula to the case of the field magnet. The length may be taken as that of a line drawn through the center of magnetic space from gap to gap, as shown in Fig. 1, and such a line will be found to be 28.06 ins. long. This determines l. N we know to be equal to 4.190474; a we have determined by the field core is 5 ins. x 11 ins. and has an area of 55 ins. It remains to find μ.

The permeability of iron or steel is very different with different compositions and varies especially in the case of steel. Indeed, so great is this variation that it has frequently been customary to cast a small slug of steel or iron on the main casting, which is broken off and its permeability determined and assumed to be the same as that of the main casting. This is probably the most accurate method, provided that the slug is not cast too thin, thereby becoming much harder than the rest of the casting. Where founders have succeeded in turning out a uniform product, resource may be had to permeability curves. In such a curve the permeability is plotted as abscissæ, and the density in square inches or square centimeters as the case may be, is plotted as ordinates, and in this way the permeability at any given density can be readily pricked off. Such a curve is shown in Fig. 2. Often the curve is plotted in what is known as a saturation curve, in which the magnetization force is plotted as abscissæ and the resulting induction or lines of force per unit of area as ordinates. Permeability is equal to magnetizing force divided by the induction, and hence if we select a point on such a curve as this at the induction at which we wish to measure the permeability and divide the induction by the magnetizing force, we shall have the quantity we require. Such curves as this have the advantage that no matter in what units they are plotted, they can be used with either the English or metric system, for permeability itself is independent of units of measure. We will consider the curve shown in Fig. 2 as a fair representative of the steel of which we are going to make the field magnet. The maximum lines of force in the field frame we have previously found to be nearly 4,950,000, which gives a density of 90,000 lines per square inch, and from the curve we find the permeability at this density is 920. We now have all the quantities in the formula and can at once compute the number of ampere turns as 726. This gives the necessary ampere turns to force the flux through the field magnet.

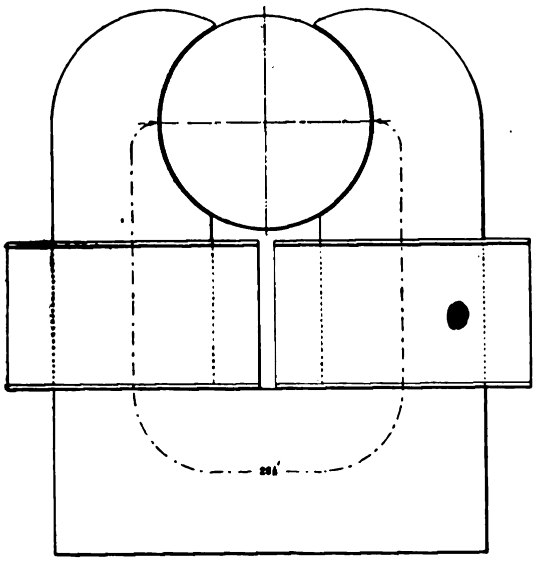


FIG. 1.—SHOWING LENGTH OF PATH IN FIELD MAGNET.

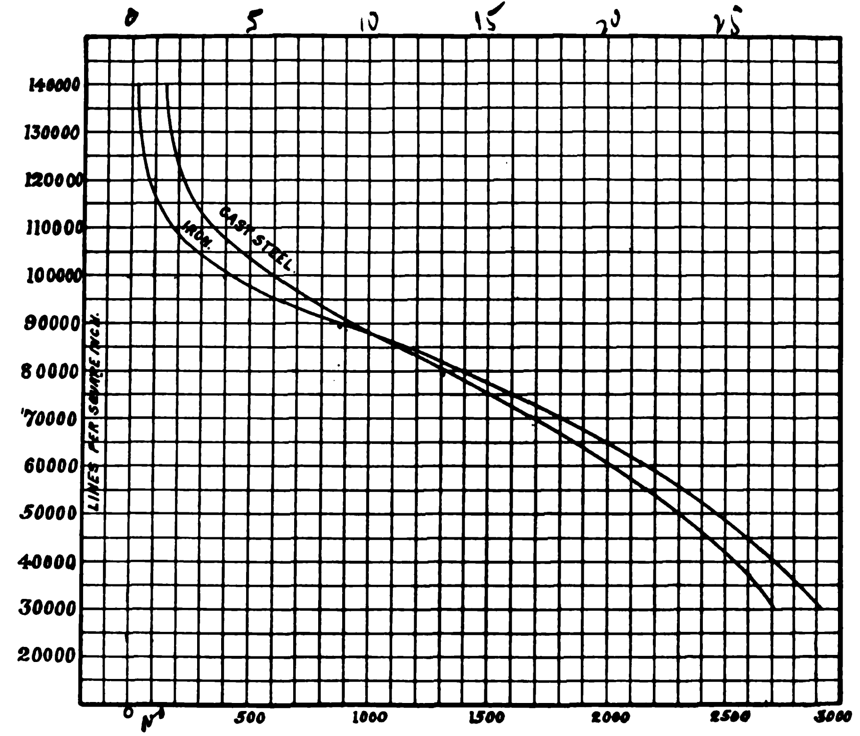


Fig 2

PERMEABILITY CURVES OF IRON AND STEEL.

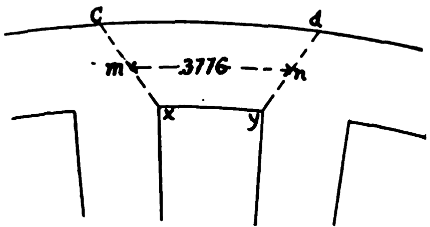
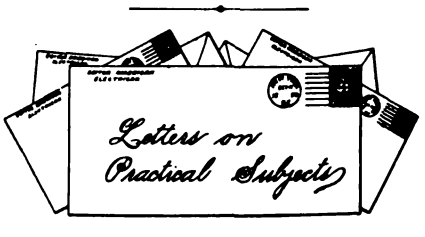


FIG. 3.—METHOD OF DETERMINING AREA OF GAP SPACE.

The next question is that of the gap space. The pole piece covers fourteen teeth in the armature and an area of at least 15 per cent additional should be allowed for fringing, to take account of the fact that the lines spread out in pyramidal form in passing from tooth to pole piece. To determine this quantity more accurately we may draw a section of the polar surface, together with several teeth, as shown in Fig. 3, and lay off the lines c x and d y, the points c and d being opposite the middle of the slots. Then measure the arc mn and this will be the proper width to use in computing the effective area that a single tooth contributes to the gap space. This will be found to be .3776 in., and multiplied by the length of the tooth and by the number of teeth covered by a pole piece we have the full area of the gap space, which is found to be 58.15 ins.: The length of the gap space is equal to twice the clearance, because there are two gap spaces, or .1 in. The permeability of the gap space is 1, for it is of air which has the same permeability at all densities. Applying the formula we find that the number of ampere turns necessary to force the flux through the gap space is 1410.



Handling Rotary Transformers.

To the Editor of American Electrician:

Sir: Possibly a great many indifferently designed and constructed electrical devices are coaxed into doing good work by unceasing care and skillful attention on the part of the attendants, but, on the other hand, how many good machines are ruined or severely damaged by careless handling and nonsensical "expert" work?

A case in point: Some new rotary transformers had just been set up temporarily to supply current during building operations. The transformers were located in a rough board shed, with no floor except the earth, with a few boards thrown around the machines. Naturally, the dust from the dry earth flew everywhere and made it bad for the transformer rings. The middle ring especially seemed to feel the dirt more than the others. The transformers were of the General Electric style, type T C, form A, class 4-100-750. I believe the middle ring does about all the work of starting the motor; at any rate, it seemed to cut worse than the rest.

The attendant had no vaseline, but he prepared a strip of cloth, folded it thick, and kept it saturated with oil. The rings were wiped off every few minutes with the greasy rag, all copper dust being thus removed as fast as formed. But the rings persisted in cutting, until one day, the night man chanced to come in early, and the attendant asked him to find a chance to sandpaper the rings that night after the load was off.

"Why," said the night man, "I sandpaper those rings every night," and then it came out that the night man had been in the habit of holding sandpaper and a block against the rings, with the brushes running in place, every time he came in at night, thus removing all traces of the cutting which the day man had not been able to stop, and making everything ready for another day's cutting by leaving the copper and sandpaper dust between the rings and the brushes after the sandpapering operation was finished.

It so happened that the machine was not run much after the night man got there, so he had just time to fill the brushes with sand, and then shut down until morning. It did not require much time for the day man to very forcibly lay down the law to the night runner, and it is safe to say that no more sandpaper dust will be found in those rotary transformer rings or brushes. The night man was directed to throw off all the brushes, after shutting down, to clean them and the rings thoroughly, then to wrap a long strip of emery cloth, or sandpaper, around the ring. The sandpaper was to pass about half way around, then the tangent ends were to be held in the hands and pulled back and forth, the armature being partly revolved while the sandpapering was progressing.

In this manner the roughness would all be smoothed off, and the brushes would not be made a catch receptacle for silex rock, or other abrasive material that might be made into sandpaper. I can add that this treatment thoroughly cured the cutting of the transformer commutator rings, and that similar management might do a good deal toward improving the running condition of many other electrical machines.

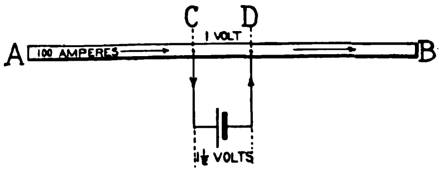
Jno. J. Holden.

Pittsburg, Pa.

An Electrical Paradox.

To the Editor of American Electrician:

Sir: In the accompanying diagram some very ludicrous conclusions may be drawn from apparently logical grounds. AB represents a feeder of, say, an electric railway system, carrying 1000 amps. The little distance DC represents a length of this feeder around which the drop of potential is 1 volt. If we apply an e.m.f. of 1½ volts to these terminals opposed in direction to the direction of the current we shall reverse the latter, stopping the main current altogether, because it is presumably impossible to have two currents flowing in opposite directions in the same wire. If this is true for the position shown we can reduce the distance CD to a smaller amount and apply a lesser voltage and the same result will still hold. If all this is true, we can take any battery, however small, and connect in this way with a sufficiently short section of a feeder carrying a powerful current and stop the latter altogether. The much mooted question of current in the Brooklyn Bridge cables could thus be very easily solved by the proper application of a few cells of dry battery. The conclusion savors so much of the impossible that, in spite of the apparently logical premises it cannot be credited; and it has been my experience that the would-be solvers of this problem are either compelled to make astonishing assumptions or quickly argue themselves into difficulties in endeavoring to evade the issue. I submit it on its merits to your readers.



AN ELECTRICAL PARADOX.

C. D. Blake.

ELECTRICAL CATECHISM.

247. What is the difference between a voltmeter and an ammeter?

An ammeter measures current, while a voltmeter measures pressure (or e.m.f.). As actually constructed, most voltmeters are simply special forms of ammeters. From Ohm's law, the current through a given circuit equals the pressure at its terminals divided by its resistance; if a high resistance is connected in series with a sensitive ammeter that will measure very small currents, then the current passing through the circuit is directly proportional to the pressure or voltage at its terminals, and the instrument may be calibrated to read volts.

248. What is meant by calibrating an instrument?

Calibration refers to the construction of the scale of the instrument, or to the determination of the value of different positions on the scale. For example, suppose that an instrument has a resistance of 10,000 ohms and that 0.001 ampere (or 1 milli-ampere) causes the pointer to move to a point say 1 in. from the zero or starting point. The pressure necessary to send 0.001 ampere through 10,000 ohms is 10 volts, since $E = C \times R$. That point on the scale might be marked either as 0.001 ampere or as 10 volts. In a similar way, the value of every other point on the scale might be determined. If the current values are marked on the scale, we say that the instrument is calibrated to read amperes or milli-amperes; while if the scale were marked to show the pressure at the terminals of the instrument necessary to give the same readings, we would say that it was calibrated to read volts.

249. Why does a voltmeter have a high resistance?

For the sake both of economy and of accuracy. By making the galvanometer very sensitive, less current is required to operate it, and as a result more resistance is needed to keep the current down to that required. Some voltmeters take so much current that they soon become heated to a dangerous degree if left in circuit continuously, and therefore the switch or push-button should be left open except when the instrument is in actual use. Even if the instrument does not become so hot as to endanger its insulation, its resistance changes as it becomes warm; this allows less and less current to pass through the instrument and it then indicates a lower voltage than that actually at its terminals.

250. Why does a voltmeter with low resistance get a poor reputation even if the switch is closed only when in actual use?

A voltmeter with low resistance takes considerable current. If the circuit whose voltage is being measured has comparatively high resistance, the additional current taken by the voltmeter may cause an appreciably greater drop on the line, so that the voltage at the point tested may be considerably lower when the voltmeter is in circuit.

251. Why are the division marks omitted in the lower parts of the scales of many instruments?

Some instruments are intended for use with currents or pressures that vary only through narrow limits, and the scale is marked only on those parts to save expense. Other instruments are not accurate for small readings and so the scales are not calibrated below a point where the instrument becomes unreliable.

252. Why are such instruments not reliable for small readings?

Partly because the friction of the moving parts is relatively great, and partly because many instruments depend upon the attraction or repulsion of soft iron cores, which is not constant for small currents at different times on account of hysteresis.

Queries and Answers.

Criticisms and extensions of the answers given in these columns will be welcomed. Windings for amateur motors and dynamos cannot be supplied, as the designs rarely justify the labor required for the calculation. The complete series of designs of small machines now being published in this journal will usually furnish data for other small machines, if intelligently applied. The privilege of this department only extends to subscribers, and queries must be accompanied by name and address to secure attention.

Can a polyphase generator be made self-exciting without the use of a D. C. commutator?

No. There must be a rectifier of some device which is closely akin to a direct commutator used in connection with the machine.

I have described a bipolar armature in which the brushes cover three segments on the commutator. I understand that the proper amount is one and one-half segments. Will the arrangement I have described cause the armature to heat excessively? G. R. R.

The arrangement you describe will make the commutation imperfect and probably cause the armature and more especially the commutator to heat more than they should.

When a common wire or common ground return is used for telephone, telegraph or trolley systems, do the different currents pass each other, thereby creating the condition of currents in opposite direction in the same conductor? H. H.

It is impossible for the current in a conductor to have two different values at the same time. It may grow greater or smaller or reverse in direction, according to the algebraic sum of various currents supplied to it. The best conception of a ground return is to consider it a reservoir of electricity from which current is delivered to and drawn from a single circuit in equal amounts. A good analogy in hydraulics would be that of a long line of pipe connecting two points in the same great body of water and through which current was forced by means of a pump.

Is there any rule to calculate the voltage between any two wires on a three-wire phase or three-phase system, when the voltage of the generator is known? M. T. K.

On the three-phase three-wire system the voltage between any two of the wires is equal to that at which the generator is rated. On the three-phase four-wire system the voltage between any of the three output wires and the fourth wire is equal to the line voltage divided by the square root of three. With the two-phase three-wire system the voltage between any wire and the common return is the rated generator voltage. The voltage between the two output wires is equal to the generator voltage multiplied by the square root of two. If independently wound on the four-wire plan the voltage between two wires of the same phase is the rated generator voltage, and between two wires of different phase is zero. With the two-phase four-wire system connected on the star plan the voltage between two wires of different phase is equal to one-half the generator voltage multiplied by the square root of two.

What method is used in determining when a storage battery is fully charged?

There are several methods of determining the amount of charge in a battery. The specific gravity of the electrolyte in the cell as measured by the hydrometer, is one of the best. The voltage of the cell is also an indication of the amount of charge it contains. To apply both of these methods intelligently it is necessary to know the kind of cell and the original density of the electrolyte used. A good way is to take the cell in a discharged condition and supply it with its rated capacity in ampere hours. At the close of that time note the specific gravity of the electrolyte by a hydrometer and the voltage by a low reading voltmeter. These readings will be criterions on which future observations can be based.

Please explain the action of the Thompson recording wattmeter. How is the speed kept proportional to the load? A. T. B.

The motor, for such it is, is wound without iron either in armature or field. Its back e.m.f. is, therefore, negligible. The armature is connected directly across the mains. The field is in series with the mains. The current in the armature is almost directly proportional to the impressed voltage, because the back e.m.f. is so slight. The current in the fields is, of course, proportional to the main current and the watts, which is the product of the two, are therefore proportional to the torque of the motor and the motor is given a load by means of the magnet and disc beneath it of such quality that its speed is always proportional to its torque and, therefore, to the watts in the main circuit, and if properly calibrated it will read in watt hours. In some cases the back e.m.f. of the motor is too great to be neglected, rendering current in the armature smaller than it should be for accuracy. In such cases a small field coil placed in series with the armature would increase the torque the proper amount.

1. What is the best method of spiraling two 3-phase lines on the same pole, working in parallel, to avoid mutual and static effects?

2. Would two barb wires arranged on separate cross-arms above be recommended as lightning protectors?

3. If a telephone 3 ft. below lower arm and with 12 ins. between centers is run, how often should it be spiraled or crossed?

4. In a step-up-step-down system using low tension machines and high tension line service, should the frame of the generators be insulated from the foundation?

5. What is the current in each leg of a Δ and Y winding? E. T. B.

1. Avoid placing wires carrying currents in the same phase adjacent to each other. Spiral the line once about every 5 miles. Be sure to have an even number of complete rotations.

2. Yes. Provided the barb wires are well grounded. In such a case, however, one wire is usually supposed to be sufficient.

3. The line should be crossed about once to a mile, and in addition at every place where the alternate current line above it crosses. Of the total length which underruns the power circuits half should be in one transposition and half in the other.

4. There is less danger from lightning for the machine if it is insulated from the foundation.

5. In the Y winding, the current in each leg is the same as the current in the line it feeds. In each leg of the Δ winding it is equal to the line current divided by the square root of 3.

How can four messages be sent over one wire at the same time by use of the Quad instrument?—R. L. C.

Two different types of instruments are used and two different types of transmitting keys. One instrument responds to a variable strength of current, but not to reversals; the other responds to reversals, but not to a variable strength of current. One key is arranged to vary the strength of the current; the other to signal by means of reversing the current. It is obvious that none of the keys and instruments mentioned will interfere with each other, and consequently that two messages can be sent over the same wire at the same time by these two principles.

In addition the services of both the intermittent and reversing systems can be developed by means of what is known as the differential principle. This is illustrated in the accompanying figure. The magnet is provided with two coils. The signaling current splits and goes around each coil of the home instrument in opposite directions, and therefore does not affect it. It enters the distant relay by only one coil, and therefore does operate that instrument if the key of the distant instrument is on the back stop. If the key of the distant instrument is on neither stop, the signaling current goes through both coils of the instrument; but, as it will be noticed, in such a direction as to have the coils assist each other in making the signal audible although the current has in this case to pass through an artificial line to the ground the double ampere turns on the receiving instrument enables the feebler current to do the work. If the distant key is on the front stop, the current in the line is neutralized by the opposition of the two batteries, but the current in the local circuit is not neutralized, because it has a free path independent of the other battery and the signal works despite the fact that the sending current was interfered with. This differential principle is combined with the one recited in the first paragraph, thus making the Quad svstem a possibility.

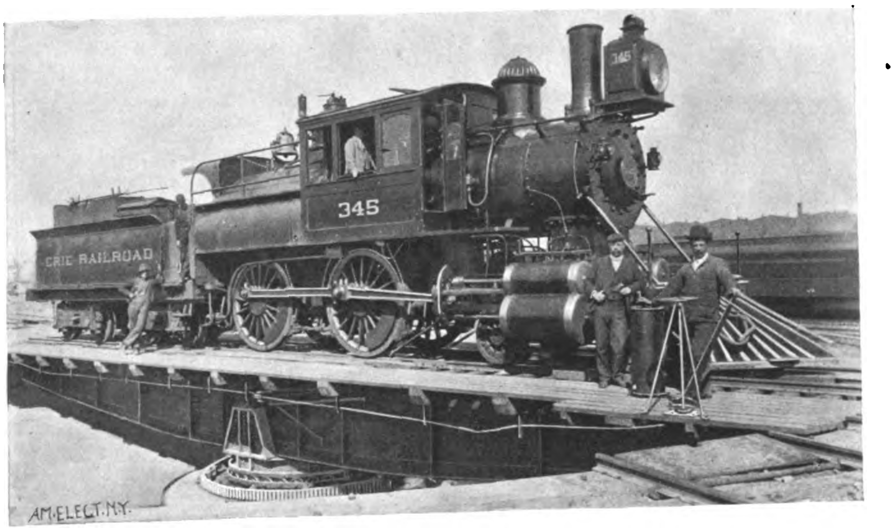
What acids are used in frosting glass, and how long must the glass be left in the solution?

The fumes of hydrofluoric acid are used for frosting glass. The parts that are to remain clear should be covered with wax and the design traced upon them. The hydrofluoric acid fumes may be generated by pouring sulphuric acid upon fluorspar spread evenly in a leaden tray. The prepared glass may be laid over the top of the tray and the latter slightly warmed. The etching or frosting is not very satisfactory, as it is not sufficiently opaque. The best results are obtained with a sand blast, in which a continuous stream of sand is blown against the glass to be frosted, by means of compressed air.

New Apparatus and Appliances

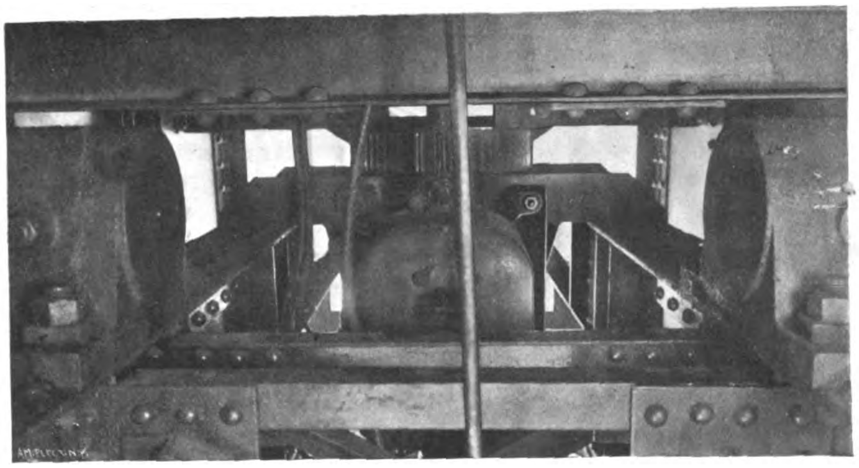
AN ELECTRIC TURNTABLE.

The Erie Railroad Company has installed an improvement in its yards in Jersey City in the shape of a new turntable driven by electricity. Although electric turntables are not new, the particular application of electricity to this one is interesting, as it involves several new features. The turntable itself is quite different from the average device for turning locomotives. It consists of a sort of a swinging drawbridge. There are two longitudinal girders which support the table platform which rest upon equalizing drums, and the entire weight rests on a set of rollers as in drawbridge practice. A pit track is provided at the outer ends of the girders, which are free to tilt down on trunnions until their end wheels rest thereon. The great problem in this drawbridge was to install the motor in such a position that the alignment would be unaffected by any motion of the table and the gears be kept properly in mesh. The motor was therefore placed upon the circular base between the girders, and is independent of any motion of the table. The power is transmitted by a double reduction system of gears, connected to a 15-h.p. series-wound motor built on the enclosed plan. The motor may be partly seen in the illustration. The upper end of the armature shaft carries a pinion which drives a gear, and the latter in turn drives a second pinion which meshes in the circle of teeth on the pier. The table is equipped with a controller at each end, and provided with reversing mechanism so that the direction of motion may be controlled. It is desirable for the operator to be directly over the end of the table, so he can see for himself when the rails are perfectly in line, and the electrical controller permits this. The current to operate this drawbridge is taken from the 500-volt power circuit of the Jersey City Electric Light Company, and is brought to a pole near the turntable and from thence the wires run underground through a cast-iron pipe to the centre of the table, where they are brought up through the vertical steel tube forming the central pivot. At the top of the table the conductors are connected to collector rings, from whence the various other wires pass to the controllers. On the pole are placed the protective devices and switches, consisting of one M. M. circuit breaker, a 75-ampere double-pole switch and two M. D. magnetic blow-out lightning arresters.



THE TURNTABLE IN ACTION.

The power required to turn the table is very small, and in practice the current is cut off after the table is turned through 35 or 40 degs., its own momentum serving to carry it the balance of the distance. The motion of the table is controlled by a band brake acting on a friction wheel, which is of sufficient dimensions to insure rapid and powerful action. The table turns from 175 to 225 engines per day and largely eliminates the congestion of traffic that has hitherto obtained in the Jersey City yards.



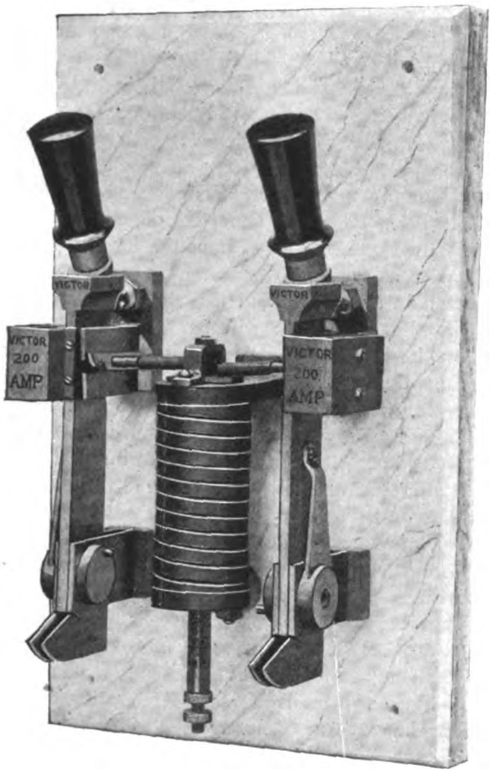
VIEW OF THE DRIVING MOTOR.

The economy of the new system has been estimated to save $270 per month, but even if no saving were made the convenience and rapidity of the electric turntable in preventing the accumulating of locomotives waiting to be turned, justifies the expenditure.

The table was built by the New Jersey Steel & Iron Company of Trenton, N. J., and designed by Mr. Mason R. Strong, assistant engineer of the Erie Railroad Company, under the direction of Mr. Charles W. Buchholz, chief engineer, and the complete electric equipment was furnished by the General Electric Company.

A NEW CIRCUIT BREAKER.

The circuit breaker illustrated in the accompanying cut has many unique features. It is a double-pole device, having two blades which can fly out independently or simultaneously. The advantage of this arrangement is that a short circuit cannot be thrown on the line without the interposition of a breaking device. One blade is thrown in at a time, and if a short circuit exists the first blade will be thrown out when the last is thrown in. The two cannot be thrown in at once, except by deliberate intent. Each blade has a separate latch and catch which acts on a roller principle, reducing the friction to a minimum. The hinged joint at the base of the blades carries on its pivot a nut which is connected by an arm to the blade itself. The closing of the blade compresses the clips of the hinge posts and improves the contact. It can be adjusted to any desired degree, and can be set to a pressure of 1000 lbs. to the square inch if necessary. This makes the hinge posts even a better electrical joint than an independent jack-knife contact. The circuit breaker is equipped with a new style carbon break of liberal capacity, and so adjusted that the copper contacts separate over an inch before the carbons, which therefore take the entire arc. This effectually prevents burning of the clips. The solenoid is wound with two coils. They are formed of bare copper and are carefully insulated between turns. The outer surface of the coil is turned and polished and presents a very fine appearance. The conducting parts of the circuit breaker are calculated on a basis of 750 amperes to the square inch. The range of adjustment of this instrument is from 100 to 400 amperes, and the normal capacity is 200 amperes. This circuit breaker is also made with under-load attachment. It is carefully calibrated and said to as reliable as any ampere meter on the market. Its installation on the switchboard is very convenient. Seven holes are all that are required to hold the circuit breaker in place on the board. These instruments have been used with great satisfaction on some of the largest installations in New York City. They are manufactured by F. A. LaRoche & Company, of New York City, and are known as the "Victor" circuit breakers.



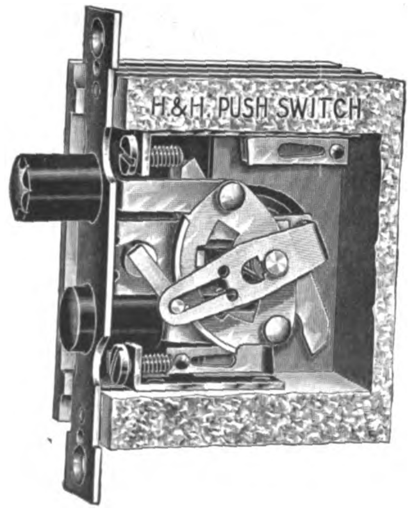
AN AUTOMATIC CIRCUIT BREAKER.

A NEW PUSH SWITCH.

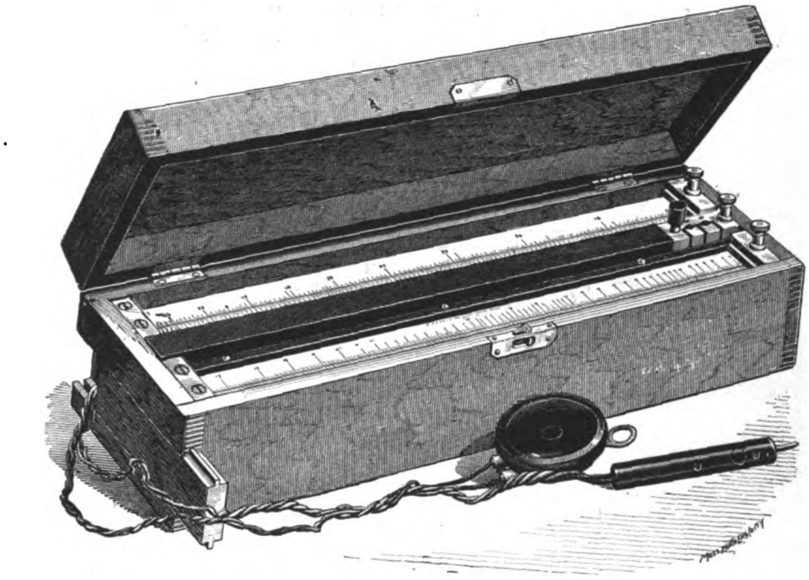
The accompanying illustration shows a new push switch which, it is claimed, is particularly desirable for use in hotels, public buildings and private houses, on account of the great ease with which it can be operated. Contractors, electrical engineers and others, who have had experience in installing push switches, know that there have been many complaints regarding them, and that a large percentage have been replaced, because they stuck or worked hard. No such difficulty will be experienced in using this particular switch. The switch is encased in a single piece of porcelain, strong and substantial, and the contacts are of the "knife switch" form. The switch plates are thoroughly insulated from the mechanism, the action is quick and positive, the break long and the carrying capacity ample. The wiring is done from the front, and all holes in the procelain which would tend to weaken it are done away with. It is stated that half the time usually required for wiring a switch is saved by the method used in the switch herewith described. The following sets forth the result of a test of this switch recently made by a large central station: "The switch tested was a double-pole Push Hart 'H. & H.' switch encased in porcelain, except the front, which was of plain nickel, and rubber push buttons, one marked to indicate light. The action of the switch was quick and positive, breaking the circuit in four places. The switch was designed for 220 volts and 10 amperes. The test consisted of making and breaking a circuit as follows:

1500 times at 115 volts and 15 amperes.
1500 " " 230 " " 15 "
200 " " 230 " " 20 "

The switch worked perfectly free and no undue heating or arcing was observed. At the end the switch was taken apart for examination and was found in good order, hardly showing that it had been used. No disastrous effect of arcing could be observed." These switches are at present made in double-pole, single-pole and three-way types. by the Hart & Hegeman Manufacturing Company, 52 High Street, Hartford, Conn.



PUSH SWITCH.



A DIRECT READING OHMMETER.

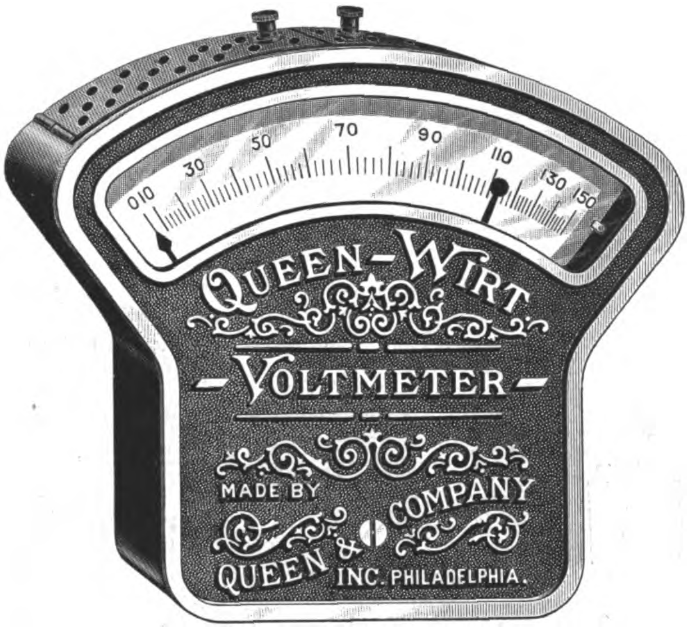
A DIRECT READING OHMMETER.

A new device for measuring resistance has been placed on the market and is depicted in the accompanying cut. It is, strictly speaking, a commercialized slide wire bridge. A wire is stretched over a scale which is divided into two parts, making the entire scale some 30 ins. long. The resistance to be measured is to be connected across the two further binding posts. A telephone is used as the detector, and a hard rubber stylus provided with a battery key is held in the hand and is touched at various points along the slide wire until a point is reached where no sound is heard in the receiver, when the resistance in ohms may be read off directly from the scale beneath.

The scale is lettered in three colors and there are three plug holes in one end of the bridge colored to correspond, and it is obvious that when the plug is placed in a hole the scale of the corresponding color responds. The resistance is connected directly across two of the binding posts, the third being provided so that other cells can be used in case the cells in the box should become exhausted and it be not convenient to renew them at once. The claims the manufacturers make for this instrument are its rapidity of operation, simplicity, adaptability to be used in any position and in dynamo rooms where strong magnetic fields are prevalent, and its cheapness. Notwithstanding the low figure at which it is sold it is thoroughly well made, being finished in polished mahogany with polished hard rubber trimmings, and accurately finished lacquered brass connecting blocks. It carries its own battery, is complete in itself and is always ready for use, and is as easily applied to a circuit as a voltmeter. It is particularly useful in running down faults on telephone switchboards, dynamos, field coils and all constructions which use electromagnets or resistances of any kind. It has just been placed upon the market by the American Electric Specialty Company of New York City.

AN ILLUMINATED DIAL SWITCHBOARD METER.

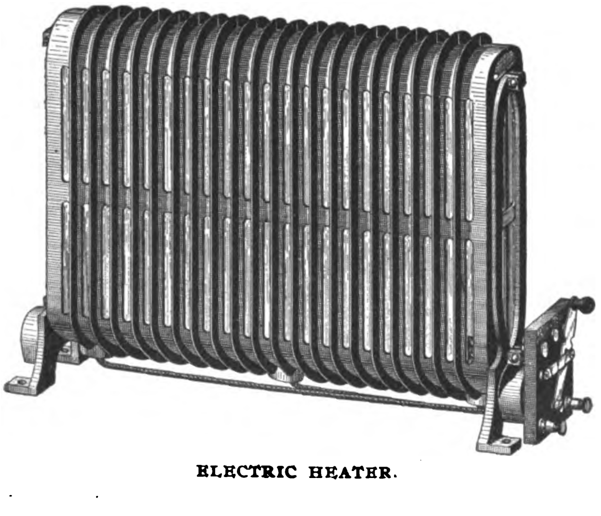
The accompanying illustration represents a new instrument which has recently been introduced on the market and is beginning to find favor in switchboard practice. It is of the illuminated dial type, the dial being illuminated by means of incandescent lamps. The instrument is enclosed in a neat iron casing, which serves as a partial magnetic shield. These meters are made for direct and alternating currents, both as voltmeters and ammeters, with any range that may be ordered. Queen & Company, of Philadelphia, Pa., the manufacturer, has great confidence in the excellence of the new instrument, and supplies with each one a certificate guaranteeing the same as to accuracy and permanency.



ILLUMINATED DIAL MEASURING INSTRUMENT.

A NEW ELECTRIC HEATER.

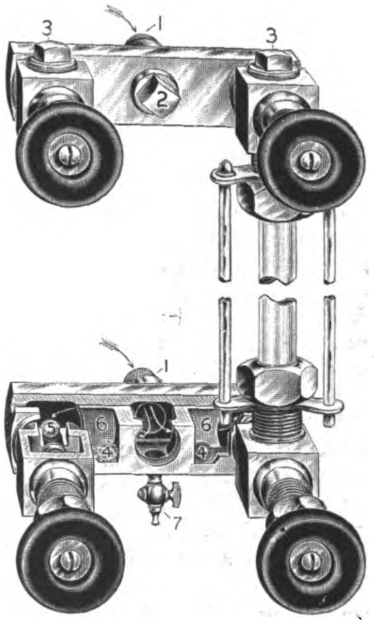
The heater shown in the accompanying illustration is made in the shape of a small steam radiator, and is 14½ ins. long, 3¾ ins. thick, 12½ ins. high, and is finished in black enamel or japan. It is made for two adjustments, half capacity and full capacity, and the switch indicates when the current is off or at which stage the heater is operating. It is adapted for 52 and 104-volt alternating currents, and also for 110 and 220 volts on direct-current circuits. The device has a wide field of application in heating small offices, bath rooms, cold corners of rooms and for general use in the spring and fall, when furnace fires are out and a raw spell comes on. These heaters are perfectly clean and do not vitiate the atmosphere. They are portable and possess in common with all other electric heaters the advantage of being always ready and of regulating the amount of heat at will. They are being placed on the market by the Western Electric Company, of Chicago.



ELECTRIC HEATER.

AN INGENIOUS WATER GAGE.

In the accompanying cut we illustrate a double automatic water gage which has many features of merit. It consists of two brass headers, if such they may be termed, which connect to the boiler directly, and the water glasses are connected between them at either end, as shown in the figure. By removing the plug, 2, the passage to the boiler may be scraped out and cleaned and all sediment removed. This is a very desirable feature, for in many water gages the impossibility of removing such accumulations renders them useless even under the care of careful firemen. The glass tubes themselves can be readily removed when broken by slacking off the packing nuts and removing the plugs marked 3. A pet-cock, 7, serves to drain both gages when that is desirable. The principal feature of this gage is the automatic arrangement for checking the flow of steam in case the glass tubes should be broken. Two brass balls marked 4 in the figure rest in pockets at the sides of the steam passage. When the glass breaks the rush of steam causes the balls to leave their pockets and forces them into the apertures at the bottom of the glass tube, thus effectually closing the outlet and preventing further escape of steam. The use of two gages is advisable, as one is a check on the other, and the determining of the height of the true water level in the boiler is too important a matter to be determined by doubtful means. The fixture is correct theoretically, and as may be readily seen from the foregoing, is thoroughly practical.

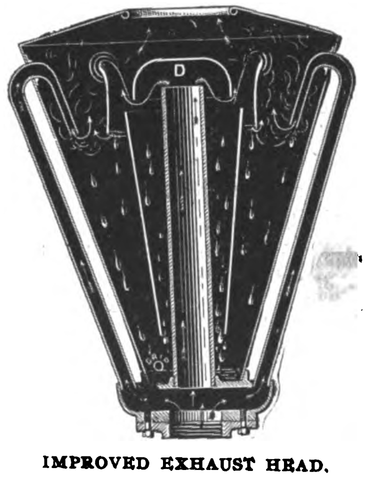


DOUBLE AUTOMATIC WATER GAGE.

This gage is manufactured by the Penberthy Injector Company of Detroit, Mich.

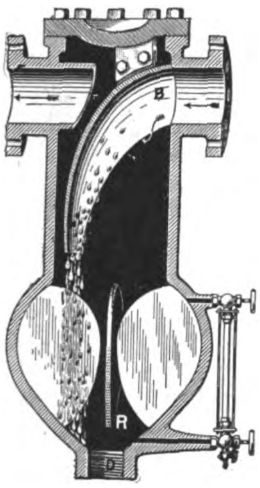
SOME NEW STEAM SPECIALTIES.

In the accompanying illustrations are depicted two important steam specialties which are the product of the Lippincott Steam Specialty Company, of New York City. The first one is an exhaust head which depends for its efficiency upon the centrifugal action caused by a quick change of direction of the exhaust steam. The special feature of novelty consists in the dividing of the steam currents into small columns, which is said to render the separation more effectual. The head is constructed of a substantial casting and is provided with a threaded central opening. The base is connected with the usual galvanized sheet iron casing, and to each of the side outlets is attached a brass or copper pipe parallel to the casing, passing to the top, as shown in the cut, at which point an elbow directs the oil to the bottom of the receiver, where a drip is provided to carry it off. The central pipe is provided with a hood which directs the steam and water, as shown by the ar-



IMPROVED EXHAUST HEAD.

rows. The casing surrounding the central tube effectually prevents the falling water being disturbed by the action of the side pipes. The side pipes afford a system of bracing which insures durability, and the large condensing surface of the head is a valuable feature.

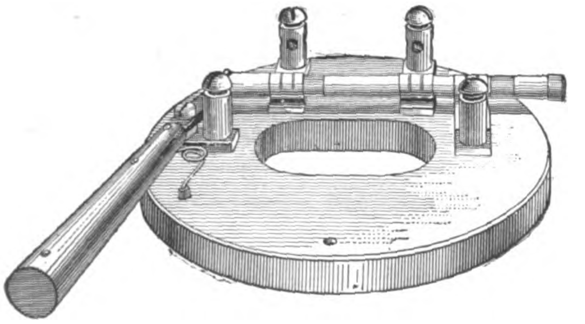


A NEW SEPARATOR.

The second cut illustrates a combined separator and oil extractor. The idea in this device is to provide a plate which will not splash the water back into the steam, as is the case where the plate is set at right angles to the inlet. This is done by making the plate of a curved shape, so that the steam and water meet it without shock, so that the latter is conducted into the receiver, where the wings prevent further disturbance by the steam. A large area around the plate is provided, so that the steam will take the course indicated by the arrows without friction. The separator is liberally designed, and is of a shape to resist internal pressure and the strains caused by the weight and contraction of long lines of piping.

AN ARC LIGHT HANGER BOARD.

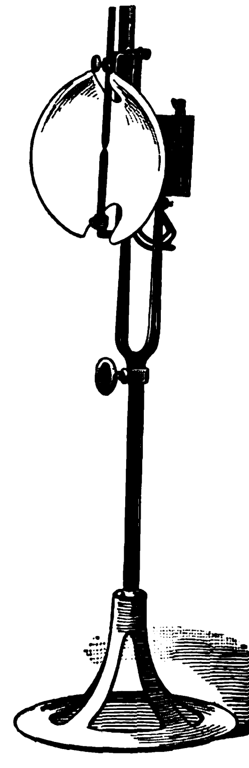
In the accompanying illustration is shown an arc light hanger board and cut-out combined. It is mounted on a fireproof base and completely cuts the arc lamp out of circuit, the action being, first, the short-circuiting of the lamp, and, second, its disconnection from the main circuit. Its merit is its simplicity. It consists merely of a rod sliding in contacts, carrying alternate sections of conducting and non-conducting material. The motion of a lever shifts this rod through the contacts surrounding it and makes the connections mentioned. A hole in the hanger board provides passage for the stack of single or double carbon lamps, enabling them to be hung very close to the board if that is desirable, and the compactness of the apparatus makes it very useful for installations in hoods for outdoor work. **The simplicity** of this board is its great attraction. It **has but two moving parts, and the four connecting blocks which all arc hanger boards** require, are simply slightly modified to include the contact rod. This combination **is a product of the K. & W. Company, of Pittsfield, Mass.**



HANGER BOARD FOR ARC LAMPS.

AN AUTOMATIC FOCUSING LAMP.

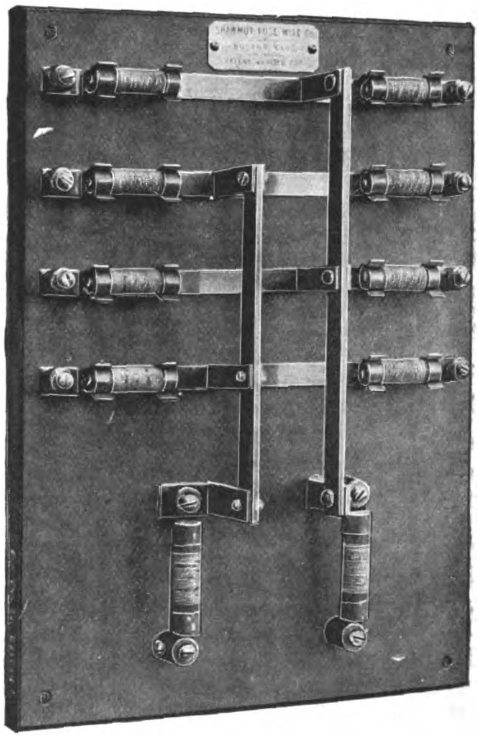
In the accompanying cut is illustrated a new type of automatic focusing lamp, for which many strong claims are made. The standard lamp is of 6000 c.p., and this can be increased when desired. The lamps will burn at any angle from the vertical to the horizontal, and are mounted on a telescopic standard fitted with ball-bearing rollers. Several of these lamps can be burned in series, thus largely saving in operating expenses. **They are so designed that they will work equally well singly or two in series, on direct current, at voltages of 110 or 220, or with the alternating current. The selling price of these lamps has been recently considerably reduced, as the maker, Chas. J. Bogue, of New York City, has largely increased his facilities and is making his lamps in larger quantities than ever before. These lamps are very popular with photo-engravers and photographers, as their intense c.p. reduces the time of exposure, thus enabling the production of more and better work in a given time.**



AUTOMATIC FOCUSING LAMP.

COMBINED TABLET AND FUSE BOARD.

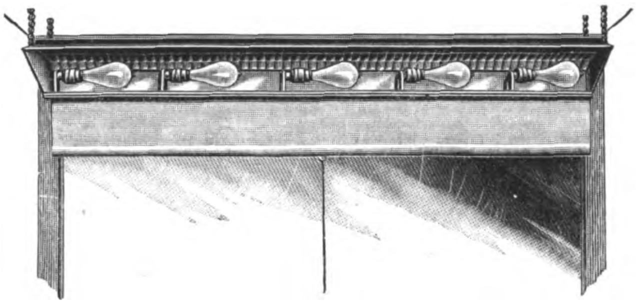
The accompanying illustration shows a combined tablet and enclosed fuse board, which it is believed will fill a demand which has existed for some time past among electrical engineers and contractors. The board is the result of some experiments, and the outcome is such that it can be manufactured at reasonable prices and cover all necessary requirements. The fuse is protected by a tube which is closed so that the gases and heated metal cannot escape. The ferrules make contact similarly to the blade of a knife switch, thereby avoiding the use of tools when fuses are replaced, a feature which will be much appreciated by those who have been obliged to place fuses in small places with a large amount of bare metal in close proximity. The device has been approved by the National **Board of Fire Underwriters, and is manufactured by the Shawmut Fuse Wire Company of Boston, Mass.**



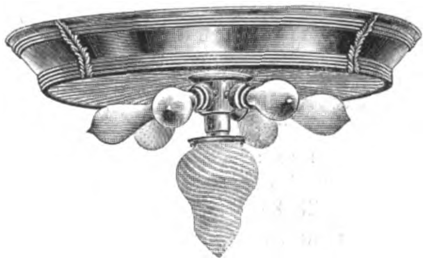
COMBINED TABLE AND FUSE BOARD.

WINDOW AND CEILING REFLECTORS.

Ninety-nine per cent of store windows are imperfectly lighted, and especially so where electric lamps are used. Most of the lamps are scattered on the bottom and at the sides of the windows where they can be seen by lookers-in, and where they attract more attention to themselves than to the goods they are imperfectly lighting. The ideal window light should light the goods and not be seen while doing so. We illustrate herewith a window reflector which is designed to be placed at the top of a window against the front glass, in such a position that it throws the light inward and downward, brilliantly lighting the window, while the glare of the direct light is shielded from the eyes of the observer. This reflector is also well adapted for lighting art galleries and telephone switchboards. Another style of reflector is shown in the illustration of a sectional glass reflector, which is intended to be placed against the ceiling, and is largely used for offices and public buildings. It can be used with or without a glass dome to conceal the lights from view, as preferred. These reflectors are manufactured by I. P. Frink, of New York City.



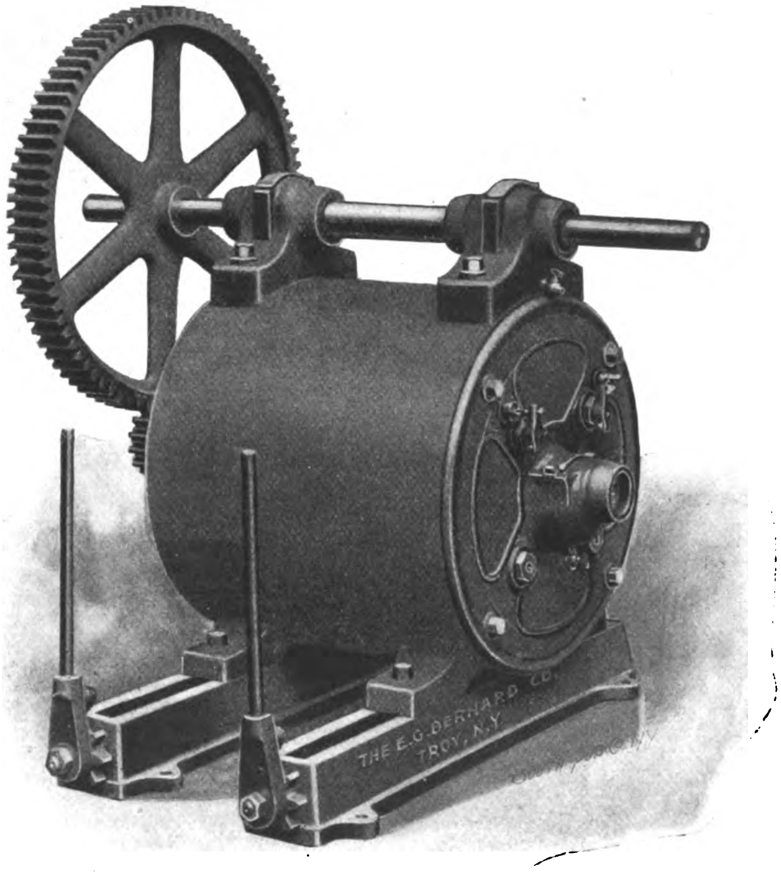
WINDOW REFLECTOR.



CEILING REFLECTOR.

A NEW ENCLOSED MOTOR.

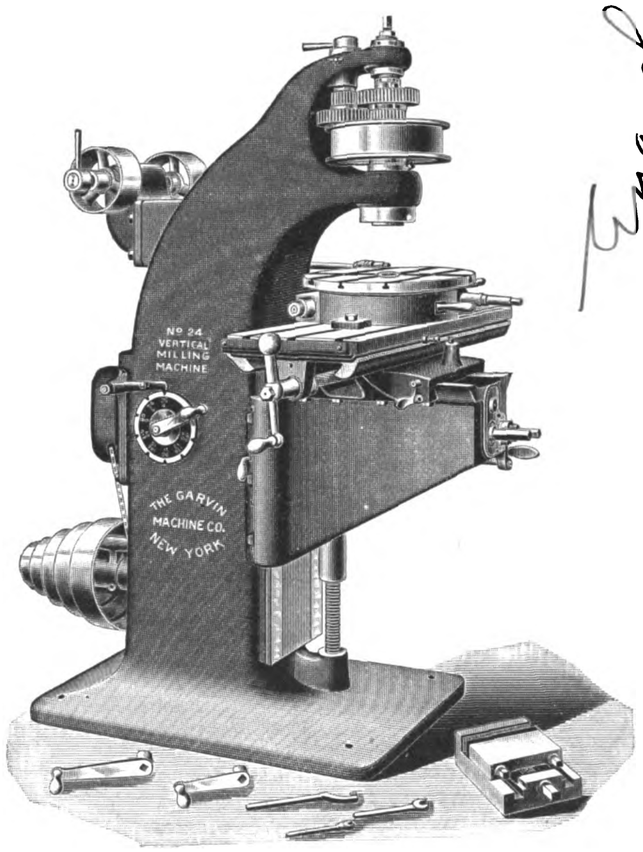
The back-geared enclosed multipolar motor illustrated in the accompanying cut has been specially designed for direct connection to shafts, machines, elevators, pumps, exhaust fans and, in fact, for all places where dust or moisture exists or economy of space is desired. They are built for all speeds and voltages, and as dynamos, are recommended for steamer lighting. Recent installations of these motors have shown them to be very rugged, and capable of operating under the most severe conditions, and notwithstanding the short time they have been on the market there are quite a number of them in operation, from 1 to 35-k.w. capacity. They have self-oiling bearings, which are always cool, and as their enclosed form is a great protection, they require little or no attention. The highest efficiency of transformation is claimed by the manufacturers, also that this type of motor will operate without sparking and heating, and will stand large overloads. India mica insulation is used, and the material in these motors is of the highest grade throughout. Every part of the machine is easily accessible. This form of enclosed motor has been largely adopted by electrical manufacturers, and has always found favor wherever it has been installed. It is manufactured by the E. G. Bernard Company, Troy, N. Y.


THE E. G. BERNARD CO.
TROY, N. Y.

BACK GEARED INCLOSED MULTIPOLAR MOTOR.

A NEW MILLING MACHINE.

The accompanying illustration depicts a new milling machine which is made by the Garvin Machine Company, of New York City. The milling tool, instead of being horizontal, is vertical, and the work is placed on a table which has motion in three directions. It is provided with power feed and reverse feeds in all directions, and all the feeds are thrown in and tripped by a single handle at the side of the knee. On the larger machine, known as the No. 24, eighteen changes of feed, ranging from .003 in. to ¼ in., are available for all directions. In addition to the original table provided is a rotary table which is arranged for both hand and power feed, and greatly increases the scope of work which can be done on this machine.



VERTICAL MILLING MACHINE.

The miller is provided with back gears and can take very heavy cuts on tough material, and therefore is alike adaptable to rapidly roughing out stock, or working to the thousandth of an inch.

This unique tool bids fair to become a very desirable adjunct to the equipment of machinists and manufacturers.

Eng. Society Library

NEW BOOKS.

Commercial Cuba. A Book for Business Men. By William J. Clark, Manager Railway Department, General Electric Company, with an introduction by E. Sherman Gould. 8 maps; 7 plans of cities; 400 full-page illustrations. Published by Charles Scribner's Sons, New York. One volume; large octavo. Price, $4.00.

This is one of the most important works which has yet appeared relative to our new possessions and "protectorates." Mr. Clark's reputation as a statistician and a man who does well everything which he takes hold of will be increased by this work, for the amount of material which he collected during some of his trips to Cuba and in this country has been simply enormous, and proved in the late war of the greatest service to the Government, by some of whose officials Mr. Clark was specially thanked and congratulated. Much of this information has been packed into this book, and many of the maps and city plans are here published for the first time. The purpose of the work is to make it possible for those who are planning to help develop the business enterprises in Cuba to enter the field with a full knowledge of the commercial and social conditions there and of the natives. The first two chapters deal with the characteristics and occupations of the people of Cuba, the third of its climate and the preservation of health, the fourth and fifth on its new geographical features and methods of transportation and communication, the sixth on currency, banking and government finance; the seventh on the legal and administrative system of the past and the future, the eighth on animal and vegetable life, the ninth on sugar and tobacco, the tenth on general statistics, and the seven remaining chapters on the different provinces and on the city of Havana. In the appendix is found a commercial directory of the island.

PERSONALS.

MR. J. A. WILLIAMS, of Cleveland, Ohio, has been on an Eastern trip on business for the Williams Electric Company, of which he is president and general manager. Mr. Williams has secured a large number of orders in Eastern cities for the magneto bell which is manufactured by his company.

MR. HENRY EAGER has resigned his position as superintendent of the Onondaga Dynamo Company, of Syracuse, N. Y., with which he has been connected since the organization of that concern. He has associated himself with Messrs. A. C. Powell & Son of the same city, who will hereafter manufacture dynamos and motors.

DR. S. S. WHEELER, the well-known president of the Crocker-Wheeler Electric Company, of New York, was married at Rye, N. Y., Oct. 11, 1898, to Amy, daughter of Mr. and Mrs. John Joseph Sutton. The ceremony was performed at the family residence by Rev. J. E. Bushnell, assisted by Rev. Dr. G. W. Knox. Mr. Gano S. Dunn was best man. Dr. and Mrs. Wheeler will occupy a house in the Murray Hill district, New York City.

MR. M. COKELEY, who is probably known to many in the electrical field, has been made superintendent of the works of the C. W. Hunt Company, Staten Island, N. Y., assuming the duties of that position Oct. 14 after several months' work revising the factory systems. Large concerns are beginning to relieve the office management of the providing for the details in office routine, the installation of systems, methods, etc. This work properly belongs to a specialist; one who, constantly keeping his eyes open for improvement, studying the best literature on the subject and devoting his energy entirely to this work, becomes an expert. Mr. Cokeley has made this special work his profession for some time, being for many years with the General Electric Company, and later with other prominent firms. His experience as a practical mechanic has been of great benefit in his line of work, enabling him to detect almost instantly the leaks that invariably exist, and which are so destructive to profits.

LEGAL NOTES.

ENCLOSED ARC LAMP DECISION.—In the suit of the Marks Enclosed Arc Light Company, 687 Broadway, New York, vs. Washington Mills Company, 74 Worth Street, New York, a decision has just been rendered in favor of the complainant. The suit was begun in the United States Circuit Court Sept. 10, 1897, and the decree granted to the Marks Company by Judge Coxe on Oct. 18, 1898. The patent infringed is No. 520,996, of Marks & Ransom, dated June 5, 1894. This patent broadly covers the method of operation used in all modern enclosed arc lamps. The Washington Mills Company were users of the Kinsman lamp, sold by the Electric Construction & Supply Company, 27 Thames Street, New York. The decision peremptorily stops the sale of unlicensed enclosed arc lamps by the latter company, and also involves the payment of damages by the defendant.

THE BATES MACHINE COMPANY, of Joliet, Ill., states that the proceedings instituted against it about two years ago in the United States Courts by the Excelsior Heater Company, for alleged infringement of a heater patent, have terminated in a complete victory for the Bates Machine Company, a decision of the United States Circuit Court of Appeals, at Chicago, the court of last resort in this case, having been handed down by Judge Woods on October 3 last, and the complainants' bill dismissed. The Cookson heater, manufactured by the Bates Machine Company, combining a heater, purifier and oil separator, has met with great favor among steam users, and its sales have increased rapidly of late. Now that the above-mentioned suit has been decided in its favor, the company anticipates a larger demand than ever before for its apparatus, and is thoroughly prepared to fill all orders promptly. The company guarantees the Cookson heater as to material and construction, and that it will produce a temperature of feed water from 206 to 212 degrees at all times, without back pressure.

A DECISION was handed down by Judge J. Thomas of the United States Circuit Court, Eastern District of New York, at a final hearing of the cases of Thomas F. Morrin vs. Thomas J. Lawler and Thomas F. Morrin, and the Clonbrock Steam Boiler Company vs. Edison Electric Illuminating Company of Brooklyn. The opinion was in brief that the defendants had infringed the rights secured to the complainants by patents which deal with the construction of the Climax boiler and the first and second claim of patent 463,307, as to the tubes, and also the improvements which the complainant is entitled to by patent 463,308. The characteristics of the Climax boiler which have been thus strongly upheld by the Court are as follows: 1. The radial tubes are to be heated by an annular grate surrounding an upright generating cylinder. 2. The tubes are arranged so that the upper branches of one tier overlap and enter the cylinder above the lower branches of the next tier above. 3. The tubes are set obliquely to the axis of the generator cylinder. 4. The tubes extend to an equal extent in the generator cylinder. 5. The tubes are of the ogee form.

The decrees will be prepared and settled on the usual notice, pursuant to the order of the Court. Messrs. Arthur von Brieson and Daniel O'Connell appeared for the complainants, and Messrs. Frank R. Lawrence and Edwin H. Brown for the defendants.

EDUCATIONAL NOTES.

THE COURSES OF ELECTRICAL STUDY of the United Correspondence Schools of New York City are reported to give entire satisfaction to all who have taken advantage of the opportunities they offer. Their scope enables any one who is desirous of perfecting himself or increasing his general information to avail himself of the advantages they offer. The courses mentioned are devoted to electrical engineering, station engineering, electric lighting, electric railways, telegraph and telephone, electro-plating, mechanical drawing, and the design of dynamos and motors is also taught in connection with them.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES has issued an attractive prospectus of 167 pages. It contains a preliminary announcement of the meetings, addresses, lectures, exhibitions, department meetings, concerts, dramatic readings, schools and courses of instruction and other work which will be conducted by the Institute and its departments during the years 1898 and 1899. Active work begins on Thursday, Sept. 29, and closes on Saturday, June 3. The number of anniversary addresses, lectures, exhibitions and department meetings open to every member is 550. The members' weekly tickets admit to each of these two persons in the evening and one in the daytime. Most of the lectures and larger meetings will be held in the halls and lecture rooms of the Y. M. C. A. Building, Fulton and Bond streets, and also in the Art Building, 147 Montague street, and in the Academy of Music, Brooklyn, N. Y.

THE ELECTRICAL ENGINEER INSTITUTE OF CORRESPONDENCE INSTRUCTION, of New York City, has secured among its instructors some of the most able men that the engineering field can produce, among which may be mentioned Prof. Francis P. Crocker, of Columbia University; Charles F. Scott, of the Westinghouse Electric & Manufacturing Company; Prof. W. J. Herdman, of the University of Michigan; Elmer G. Willyoung, the well-known instrument expert; William Maver, Jr., the telegraph authority; Thorburn Reid, the well-known dynamo designer; Dr. Frederick S. Kolle, the X ray expert; Joseph Sachs, insurance inspector and authority on interior wiring; Townsend Wolcott, the well-known consulting electrical and mechanical engineer; Arthur N. Mansfield, the well-known telephone authority; Alfred E. Wiener, the electrical engineer and author; Hugh M. Wharton, of the Westinghouse Electric & Manufacturing Company; J. Appleton, of the Electric Storage Battery Company, and Herman A. Strauss, electrical engineer. Whatever these gentlemen write will be worth reading, and when written with a view to make matters clear to the uninitiated there is no doubt that their work will be of double interest to the student who is assured that he is consulting the work of well-known experts.

TRADE PUBLICATIONS.

MESSRS. HUEBEL & MANGER, of Brooklyn, N. Y., are circulating their No. 4 catalogue for 1899, which describes their bells, push buttons and other electrical goods. A great variety of household electrical appliances are illustrated, including switches, letter boxes, binding posts and parts of electrical apparatus.

THE PITTSBURGH TRANSFORMER COMPANY, of Pittsburgh, Pa., has issued to the trade a catalogue of its type K transformers, which is descriptive of its construction, and also includes a table of tests showing the performance of the transformers to good advantage. It claims many advantages of construction and economy in its product.

THE WILLIAM POWELL COMPANY, of Cincinnati, Ohio, have issued a pocket edition of their No. 7 Steam Catalogue. Besides describing in detail their very complete line of goods, this catalogue contains valuable tables for the use of steam engineers. These in themselves are of sufficient value to make the book a desirable acquisition.

THE NEW BRITAIN MACHINE COMPANY, of New Britain, Conn., is distributing to the trade two new catalogues. One is devoted to the Case high-speed automatic engines, which are well known, and are largely used for direct connection to small dynamos, which have an excellent reputation. The other describes a mortiser for woodworkers.

THE LOMBARD WATER-WHEEL GOVERNOR COMPANY, of Boston, Mass., has issued a catalogue describing and illustrating its water-wheel governor, which has made such a reputation for prompt and accurate control of turbines. The book contains many diagrams taken from various plants, which eloquently describe the merits of the device. The governor is a standard hydraulic station fixture and is well known to engineers.

THE MASON REGULATOR COMPANY, of Boston, Mass., has just completed a new catalogue of its steam devices, which is well illustrated and describes its hydraulic dampers and regulators, reducing valves, pressure regulators, balanced valves, pump governors and other well-known steam specialties. It is a valuable work of reference for the many engineers who have adopted this apparatus for their standard.

JAMES G. BIDDLE, of Philadelphia, has just issued to the trade a new catalogue known as Catalogue B, devoted to descriptions and illustrations of electrical measuring instruments. The catalogue includes data of the Jagabi portable testing sets, Weston instruments, circuit breakers and various forms of rheostatic devices. It contains data of particular interest to college and professional men, relative to electrical measurements.

THE FARR TELEPHONE & CONSTRUCTION SUPPLY COMPANY, of Chicago has just issued a new catalogue, describing its goods. The company is a wholesale dealer in telephone supplies, and handles complete box telephones of all sizes and for all purposes. Its portable telephones, long-distance telephones, generators, receivers, transmitters, switchboards and lightning arresters, together with a full line of minor telephone accessories, are described in the book.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, Pa., has issued Circular No. 45, describing the installation of the Barre-Montpelier Traction Company, reprinted from the "Street Railway Journal" of September, 1898. It will doubtless be remembered that the various forms of storage batteries of this company have been described in a series of these circulars, which are of uniform size and suitable for subsequent binding. The set, when completed, will furnish a book of valuable information on storage batteries.

A NEW CATALOGUE on focusing arc lamps is being circulated by the Baker & Fox Company, of Brooklyn, N. Y. The catalogue describes both hand and automatic lamps in detail. The lamps are very simple, and ought to be durable and efficient. They are said to be unaffected by dust or grit, and require no attention. They are made for direct or alternating currents or both. These lamps are particularly adapted for every variety of college, theatre or lecture work and photo-engraving. The company will send copies of its catalogue to those interested.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY of Chicago, one of the largest independent telephone companies in the world, has recently issued a new catalogue which describes its telephones, transmitters, receivers, switchboards and telephone appliances of all kinds. This company prides itself on the high grade of its instruments and the general all around excellence of its workmanship. The catalogue is copiously illustrated and minutely descriptive of the apparatus. It is supplemented with frequent illustrations of the facilities of the company for manufacturing on a large scale.

THE NEW CIRCULAR of the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., on polyphase inductor generators is interesting, as it describes and illustrates in detail the machines of this type that the company is now producing, which are a distinct departure from their former practice. The rotating part or inductor contains no moving wire. The field coil is concentric with the shaft, and is stationary. The company has also issued another circular on Rotary Transformers for Electrolytic Work which is beautifully illustrated and replete with technical detail of interest and value.

THE GOULDS MANUFACTURING COMPANY, of Seneca Falls, N. Y., is distributing to the trade a new catalogue which is devoted to its electric triplex power pumps, and illustrates the many appliances and methods of connection which may be successfully used with these devices. Where so many pumps of large size are daily in use, the question of economy becomes an important item, and, as the engineering trade knows, there is no device so wasteful of its power as the ordinary steam pump, which it is believed will soon be supplanted by the electric pump. This catalogue should be interesting to engineers of all classes.

THE C. W. HUNT COMPANY of New York City has issued a catalogue entitled "Industrial Railways," which is descriptive of its practice in railways for the handling of coal, bark, cinders and other materials which it is desirable to transport in large quantities with a minimum amount of handling. The book contains upward of 130 illustrations, all of which are extremely interesting to the managers of electric power stations, founders, machinists, and everyone who, in the course of his business, has heavy weights to handle. In another catalogue the company describes mast fittings, coal scoops, pulleys and sheaves and similar devices, and in a third publication it describes the various ropes for rope drives, for which the C. W. Hunt Company has become famous. The catalogue on rope driving has an illustrated appendix containing a great deal of valuable technical data.

THE NEW CATALOGUE of the Electric Appliance Company, of Chicago, Ill., has just been issued, and is a very complete description of its telephone apparatus and appliances. It calls particular attention to a new automatic hook of the company's own design, and very strong claims are made for it. The hook is easy to install and occupies but little space. It is assembled and adjusted before shipping, and is certain to reach the customer in good order. The contacts are visible upon opening the door, which facilitates inspection and wiring. It is constructed with a cam at the back to prevent the lever from being bent out of shape, and is apparently a very useful article. The catalogue contains ninety-six pages, and is well indexed, and every appliance is well illustrated and described, making the book particularly desirable and valuable for the trade files of the contractor and engineer.

"IMPROVED BRUSH ARC LAMPS" is the title of an artistic brochure just issued by the General Electric Company dealing with the modifications introduced in the latest types of single and double Brush arc lamps, as experience with the operation of past types has dictated. Each detail of improvement is explained clearly and concisely, and in conjunction with first class half-tone illustrations, so that even persons unfamiliar with the Brush lamp mechanism will find no difficulty in grasping the import of the various changes and improvements. The leading features are summarized, each under its own heading, and the brochure concludes with a full catalogue of the parts not only of the improved lamp, but also of lamps 30 and 31. The pamphlet is issued from the General Electric Company's own printing office, and in general artistic appearance, letter press and illustrations, compares well with the work of our best catalogue makers. It will be sent to those interested on application to any of the company's sales offices.

THE ELABORATE TREATISE ON MECHANICAL DRAFT recently issued by the B. F. Sturtevant Company, of Boston, Mass., is unique as a trade publication, in that it presents no personal claims for the merit of the system or the apparatus necessary for its operation, but relies solely on the statements of unbiased witnesses to emphasize its features. For this reason the following quotation from this important work is of especial interest and value. It consists of a summary of the especial advantages of mechanical draft as presented by the well-known engineer, Mr. Alfred Blechyden, in a paper before the British Institution of Mechanical Engineers. He says: "First, it seems fairly well established that, if the boilers are well constructed and are provided with ample room to insure circulation, their steaming power may without injury be increased to about 30 to 40 per cent over that obtained on natural draft for continuous working, and may be about doubled for short runs. Secondly, such augmentation is accompanied, in normal cases, by an increased consumption per i.h.p. But, thirdly, the same or even greater power being indicated it may, with moderate assistance of forced draft, be developed with a smaller expenditure of fuel, the grates, etc., being properly proportioned. Fourthly, forced draft enables an inferior fuel to be used; and, fifthly, under certain conditions of weather, when, with normal proportions of boiler, it would be impossible to maintain steam with natural draft, the normal power may with forced draft be insured. In particular cases any or all these advantages may be a source of economy, and the first of them may render possible that which would otherwise be impracticable.

BUSINESS NEWS.

THE OTTO GAS ENGINE WORKS, Philadelphia, state that they have recently installed two 120-h.p. Otto engines for street railway service, at Stockton, Cal.

A. C. BECKEN, of Chicago, Ill., reports a brisk demand for the Paillard non-magnetic watches. These watches are unaffected by electrical machinery or other powerful magnetic influences.

M'LEOD, WARD & COMPANY, of New York City, report unprecedented sales of their Kinsman desk lamps. The Ward orchestra lamps are also meeting with a large demand from all parts of the country.

THE BOSSERT ELECTRIC CONSTRUCTION COMPANY, of Utica, N. Y., is manufacturing a switchboard to be used in the post office at Atlanta, Ga. Kingsbury, Samuel & Company of Baltimore, have the contract.

THE CENTRAL TELEPHONE & ELECTRIC COMPANY, of St. Louis, Mo., is doing a large business in telephone supplies, and has installed a telephone repair business, which is a new development in the telephone field.

THE C. McINTIRE COMPANY, of Newark, N. J., the well known manufacturers of terminals and connectors, is now making a specialty of fuse wire, fuse links and strips, which are finding much favor among contractors.

PHILLIPS INSULATED WIRE COMPANY.—The increase in the business of this company has made it necessary to begin the erection of a large four-story-and-basement brick addition to their present factory at Pawtucket, R. I.

WILLIAM ROCHE, of New York City, is now offering to the trade a miniature battery, oval in form, 1⅝ in. by 1⅛ in. over all, which is especially intended for necktie pins, cataphoresis and similar purposes. The Roche No. 2 cell is meeting with great favor among telephone men.

THE BECKER NAME PLATE COMPANY, Boston, Mass., is sending out to the trade an attractive paper knife and envelope opener, which will be found a useful souvenir as well as serve to remind manufacturers that the Becker Company is prepared to supply all demands for ornamental and handsomely finished name plates.

THE MONTAUK MULTIPHASE CABLE COMPANY, of New York City, reports excellent business, and states that its cable is finding great favor. It has received a communication from the Milwaukee Auxiliary Fire Alarm Company, indorsing and authorizing the use of its cable in connection with the auxiliary system of Milwaukee, Wis.

ELECTRICAL WORKERS' UNION NO. 3 will hold its annual ball at Murray Hill Lyceum, New York, Nov. 7, 1898. As the receipts are to be turned into the fund for the benefit of the sick and the relatives of the deceased members of the organization, it is hoped there will be a large attendance. An unusually interesting programme has been provided.

THE AMERICAN ELECTRICAL HEATER COMPANY, of Detroit, Mich., reports a good business in its newly designed portable electric heater. The company has had a great deal of experience in portable heaters, and the simplicity and efficiency of its latest product, together with its good workmanship and low price, is responsible for its popularity.

THE BUCKEYE ELECTRIC COMPANY, of Cleveland, Ohio, says that its special coiled filament lamp represents that which all manufacturers have striven to produce, namely, the lamp which shows practically a straight line c.p. curve for 500 or 600 hours when burned at normal voltage. The company is now carrying a large stock of lamps at its Chicago office.

THE LIPPINCOTT STEAM SPECIALTY COMPANY, of New York City, is doing a good business in the manufacture of steam engine indicators, oil filters and a full line of engine and steam supplies. The company's headquarters is at 169 Broadway. It has already circulated copies of its new catalogue, and is preparing a special catalogue for distribution among engineers.

THE CROUSE-HINDS ELECTRIC COMPANY, of Syracuse, N. Y., has an excellent equipment for turning out the finest class of work on switches and panel boards. The company carries a large line of these goods, which are described in its catalogue. It has a large corps of engineers and draughtsmen, and is in a position to quote prices on all kinds of special work of this class.

A DIVIDED CIRCUIT TOLL LINE TELEPHONE SYSTEM is being brought out by the Stromberg-Carlson Telephone Manufacturing Company, Chicago, that is claimed to be entirely free from the broad claims of the Carty patent on the bridging system, recently upheld in Pennsylvania as valid. It is said to have some new and improved features, compared with the regular bridging or series systems.

THE ROE STEVENS MANUFACTURING COMPANY, of Detroit, Mich., states that its Scott gate valve and the globe angle and safety valves are very popular abroad, where they have been tested in some of the more important government work. They have recently made large shipments to London, Hamburg and Christiania, and are making a second shipment of six 30-in. gate valves to Honolulu and Hawaii.

MR. H. T. EDGAR, who is in charge of the New England office of the Jandus Electric Company, states that its inclosed arcs are to be installed in the new Boston Terminal Station, which, when completed, will be the largest structure of this kind in the world. The lamp was selected by Westinghouse, Church, Kerr & Company, who are installing the entire equipment of the electrical plant.

THE PHOENIX IRON WORKS COMPANY, of Meadville, Pa., reports an excellent business, having recently taken orders for tandem compound engines aggregating about 2000 h.p., and in addition quite a number of simple direct connected engines. The company has supplied five engines for the Park Row Building in New York City, which is thirty stories high and, without doubt, the highest office building in the world.

THE SNOW STEAM PUMP WORKS, of Buffalo, N. Y., reports that it has secured the contracts for furnishing the pumps on a Russian battleship and cruiser and also the American battleship "Maine," which are now being constructed. It is understood that the contract was awarded on competitive plans, and speaks well for the high degree of excellence which has been achieved by the Snow Steam Pump Works in its well-known apparatus.

THE KEASBEY & MATTISON COMPANY, Ambler, Pa., is manufacturing a magnesia covering for steam pipes and all heating purposes. Robert A. Keasbey is the sole agent in New York State. It was incorrectly stated in our last issue that the boilers and steam pipes in the plant at the Grand Central Depot were covered with magnesia covering. The work was done by the H. W. Johns Company, of New York, which used its well-known asbestos covering.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, of Philadelphia, Pa., though not quite one year old, has made active progress, and is now classed among the largest electrical supply houses of the country. The success of this house is largely due to Mr. Roberts himself, who is a hard worker of large experience. The prompt attention which the company gives to its orders has undoubtedly done much to secure and hold its large and rapidly increasing business.

THE CABINET MANUFACTURING & SUPPLY COMPANY, of Cleveland, Ohio, states that it has purchased the business of the Cabinet Manufacturing Company, of Steubenville, Ohio. The headquarters of the new company are at Cleveland. The company manufactures all kinds of cabinet woodwork, and makes a specialty of telephone woodwork. It wishes to inform the trade that it is in business to stay, and has ample facilities for filling all orders promptly and with satisfaction to its patrons.

THE ORIENT ELECTRICAL COMPANY, Youngstown, Ohio, reports that its factory is running overtime to keep up with numerous large orders received for its well-known incandescent lamps. The company is making extremely low prices on its product, and the experience of thousands of users has demonstrated the reliability of the company's claims regarding the quality, long life and high efficiency of its lamps. Lamp users will do well to get prices from the Orient Company before placing orders.

THE AMERICAN PEGAMOID COMPANY, of New York City, recommends its aluminum paint, which has many qualities which are valuable in electrical industries. It dries quickly, is untarnishable, washable and water, oil, grease and weather proof. It is stated to be excellent for protecting and decorating motors, dynamos, lamp brackets and metal work of all kinds. It possesses the important property of being very adhesive to the article to which it is applied, and electrical manufacturers will do well to look into its merits.

THE RICE & SARGENT ENGINE COMPANY, Providence, R. I., has in operation in the machine shop of the Brown & Sharpe Manufacturing Company one of its cross-compound condensing engines, of 350 i.h.p. This new engine took the place of a pair of non-condensing simple engines of the Corliss type, one of which was built in 1872. The change has effected a saving of 10 tons of coal a week. The gain in economy illustrates the great advance made in steam engineering during the past twenty years, and, moreover, speaks volumes for the efficiency of Rice & Sargent engines.

THE EUREKA ELECTRIC COMPANY, of Chicago, Ill., has opened a telephone business, and will manufacture telephones, switchboards, receivers and electrical appliances. It proposes to supply to the trade high-grade instruments at reasonable prices. The management is one of wide telephone experience, and comprises the following gentlemen: Mr. I. J. Kusel, president; Mr. H. J. Kusel, secretary and treasurer, and Mr. A. J. Kusel, superintendent of the factory. These men have long been in the telephone field in both its commercial and technical phases, and their wide experience and ability will undoubtedly insure the company's success.

THE ROCKWOOD MANUFACTURING COMPANY, of Indianapolis, Ind., has just made arrangements with Mr. George Child, Monadnock Block, Chicago, to represent it in the Central States. Mr. Child will handle the Rockwood patent friction pulleys, which are already so well and favorably known among power users. This company reports a large number of sales recently made for export service, and it is becoming quite evident that power users abroad are rapidly awakening to the valuable efficiency and economy of another American product. The Rockwood Company is to be congratulated over the enviable success it has attained with these pulleys.

ROUSSEAU'S ELECTRICAL WORKS, New York City, report the receipt of a large number of orders for their window and door springs, and also electric gas burner attachments. A large stock of these specialties is now being manufactured, so that all orders, no matter what size, can be filled promptly. Mr. Randolph Meikleham, secretary of the company, exercises careful supervision over all work turned out, and his long experience in this business is a guarantee that none but the best workmanship and the best material are used in the company's product. Supply dealers and others are invited to correspond with him for prices and other information.

JOHN STEPHENSON COMPANY, New York City.—On application made by Charles H. Davis, president; L. M. Delamater, secretary and treasurer, and A. L. Phillips and B. P. Flint, directors, Justice Cohen has appointed Albert A. Wilcox and Louis Stern receivers of the above corporation. The petition states that the company cannot meet its maturing obligations. The Stephenson Company is one of the oldest and largest manufacturers of cars in the world, and is at present carrying out a number of important and valuable contracts from which, if they can be completed, considerable profit can be realized which will be of benefit to the creditors of the company. The assets are stated at $1,175,776, and the liabilities $788,772.

WICKES BROS., the well-known builders of boilers, Saginaw, Mich., have found it necessary, on account of their rapidly increasing business, to open a Chicago office, at 1214 Marquette Building. This is in charge of Mr. W. S. Huyette, the contracting engineer of the company, who has been eminently successful in his past efforts for this company. Messrs. Wickes Bros. have just closed a contract with Armour & Company, Chicago, for eight 250-h.p. units for Armour & Company's new elevator, which, it is said, will be one of the largest in the world. In addition, they will install twelve vertical water tube boilers, of 375 h.p. each, in Armour & Company's new central station plant at the Stock Yards. This installation will be one of the largest in the West.

THE GOUBERT MANUFACTURING COMPANY, of New York City, states that it is exceedingly busy, and has recently booked the following orders: One 3000-h.p. heater for one of the New York & Pennsylvania Company's pulp mills; one 3000-h.p. heater for the Cleveland Electric Railway Company, of Cleveland, Ohio; one 5000-h.p. auxiliary heater for the Metropolitan Street Railway Company, of New York City, making 35,000 h.p. now building for that company alone. It has also just delivered a 3000-h.p. heater to the People's Electric Light Company, of Newark N. J. These orders are in addition to the regular calls on the Goubert Company for heaters of smaller sizes, and are certainly suggestive of the magnitude of modern steam plants.

THE ABENDROTH & ROOT MANUFACTURING COMPANY, of New York City, is the sole manufacturer of spiral riveted pipe, which has demonstrated its great strength, durability and the ease with which it can be handled. The company reports that its business in that commodity is constantly increasing. Among the large orders it has received recently are the following: Sheely & O'Shee Company, of Lincoln, Neb., 12,000 ft. of pipe, which will be used in extending the waterworks at Lanesboro, Minn.; 10,000 ft. to the city of Milledgeville, Ill., and 15,000 ft. to the city of Augusta, Wis. The U. S. & Steam Supply Company, contractors, of Kansas City, has also placed an order for about 5000 ft. of pipe, which will be used at Concordia, Mo., and 6500 ft. are to go to J. L. White, contractor, Wyoming, Ill.

THE JENNEY ELECTRIC MANUFACTURING COMPANY, of Indianapolis, reports that it is very busy, and is having about all the work it can turn out with its present equipment. This company has, however, just begun the installation of a 23-in. American turret lathe, built by the American Turret Lathe Company, of Chambersburg, Pa. This lathe is the first of its type, and especially constructed for rapid work on motors and dynamos, being the largest ever built for this particular class of work, the total weight being 10,000 pounds, and being adjustable to cut a shaving of from a fraction of an inch to 10 or 12 ins. With this and the other approved appliances which the Jenney Company is putting in, it will be enabled to meet the large demand for the Jenney apparatus, the reputation of which is undoubtedly excelled by none.

POWER TRANSMISSION FOR ORILLIA, ONT., CAN.—Active steps have been taken by the municipal council of the corporation of Orillia, Ont., Can., toward the development of an electrical power transmission plant, for the supplying of current for municipal and commercial purposes. Tenders will be asked at the earliest opportunity for the necessary electrical and hydraulic apparatus and construction work for a plant capable of transmitting 1500 h.p. as a first installment, from a point called Ragged Rapids, on the Severn River, to the town of Orillia, a distance of eighteen miles. The enterprise has been placed by the council in the hands of Mr. Roderick J. Parke, consulting electrical engineer, of Toronto, Can., who is now preparing specifications to gov-

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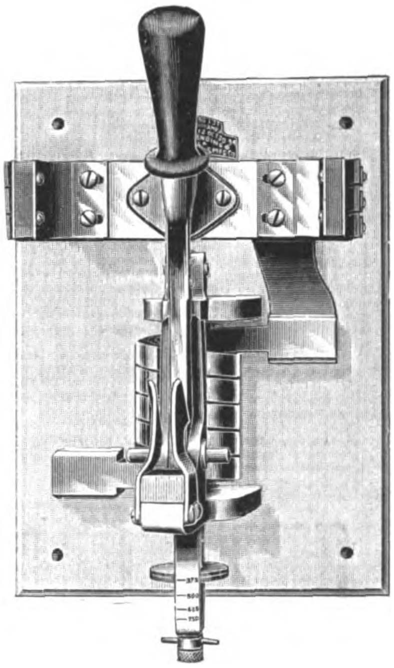

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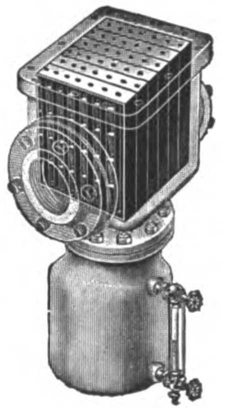

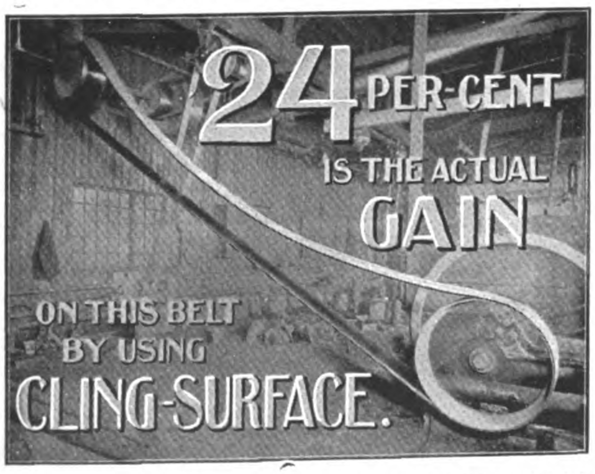

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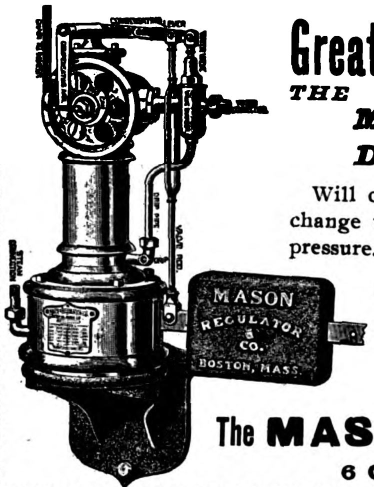
THE STANDARD THERMOMETER & ELECTRIC COMPANY, Peabody, Mass.—The plant of this company is one of the most complete of its kind in this country. Everything that is necessary to an arc lamp, with the single exception of the glass globe, is manufactured from the raw material in the company's own factory. This insures the careful supervision of every detail in the manufacture of a lamp, and does away with the annoyance of waiting for parts not made by the manufacturer before the lamp can be assembled. The business has steadily grown from the time that a part of one floor was all the space required, to the present time, when it completely fills the large four-story building now occupied by the company. The factory is now running night and day to its fullest capacity. Orders for their new alternating arc lamp are especially large, many of these being from large users abroad, where these lamps have met with much favor.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY has received a letter from Mr. R. G. Vance, Jr., superintendent of the Stevens Coal Company, which makes the following statements regarding the Baldwin-Westinghouse electric mine locomotive in operation in their mines: "It gives us pleasure to say that this motor is giving the very highest possible satisfaction, and is attracting considerable attention in this valley. It has been running since May 1, and has not cost a dollar in the shape of repairs, excepting a new valve for sandbox and a headlight base broken in a collision with a car. It is running on a road of 25 lb. steel 4000 ft. long, over undulating grades varying from 1 to 6 ft. per 100 ft. Its regular load now consists of twenty cars of 1½ tons capacity, and the time required for each round trip is from 17 to 19 minutes. We have pulled up as high as twenty-five of these cars at one trip, which it did with all ease. When necessity requires we can pull thirty cars, giving 50 per cent more capacity than you guaranteed." This is evidence of the superior qualities of this mining locomotive, which is characteristic of the work done by the Baldwin and Westinghouse companies.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, will probably move into its new factory at Norwood, Ohio, in about two weeks. The company has been so rushed with orders that it has been unable to spare time to build the electrical apparatus for its own use in the new factory. It is building two large generators, which are to be direct-connected to a cross compound engine, built by the Lane & Bodley Company, of Cincinnati. These generators will furnish power for the machine shop, which is to be operated entirely by electric power. The Bullock Company is getting out a new type of enclosed motor for use in factories and machine shops, for direct connection to cranes and machine tools. The Pacific Coast Borax Company ordered ten of these motors, aggregating 160 h.p., to be geared to various tools. The Midland Steel Company has ordered some of these motors for its traveling crane, and the Bullock Company has received two orders for this type of motor to be placed directly in headstock of lathe. The New York "Sun" has just ordered from the Bullock Company another 30-h.p. press equipment, to be a duplicate of the equipments the company furnished them before. This equipment is for the Bullock Teaser System. The Toronto "Globe" also has ordered from the Bullock Company a like equipment of 40 h.p. for a large Hoe press. Unwin Bros., of London, have ordered another press motor like their last. The Bullock Company also has entered orders for a couple of generators for direct connection to gas engine, and a 100-h.p. motor and 150-k.w. generator, slow speed, three bearings, for J. B. King, Roslyn, L. I. Besides the above, the Bullock Company has received many orders for its standard apparatus. The above is a sample of the various types of machines for direct current which one company is building.



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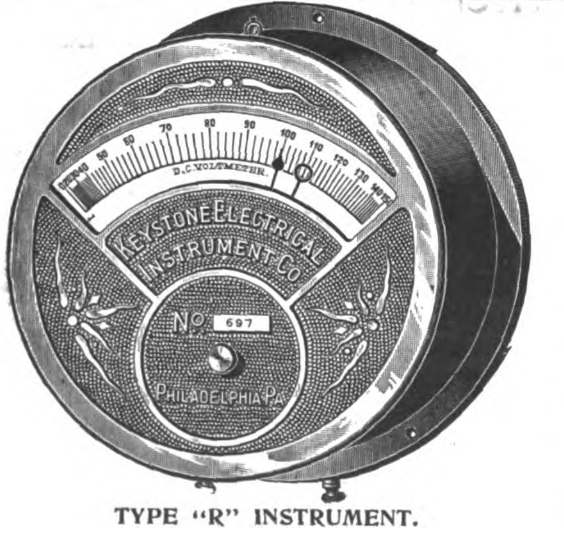
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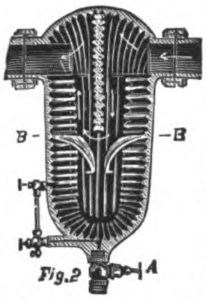

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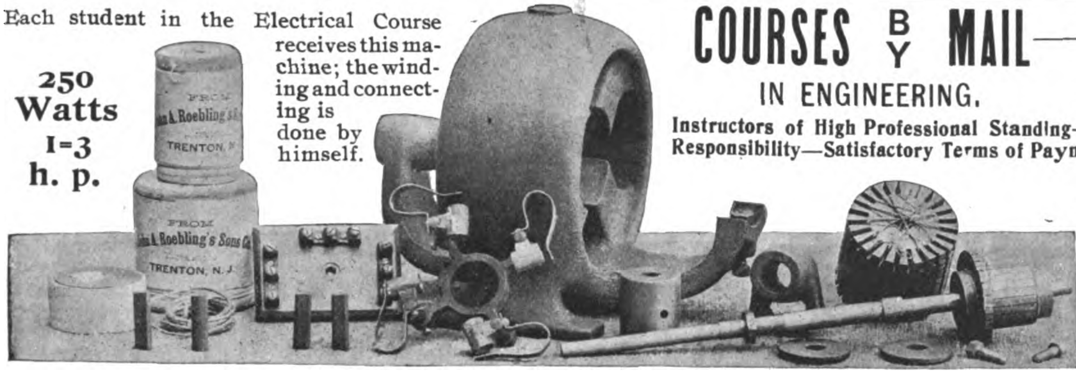

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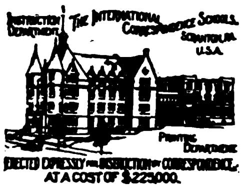
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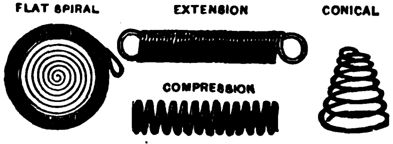

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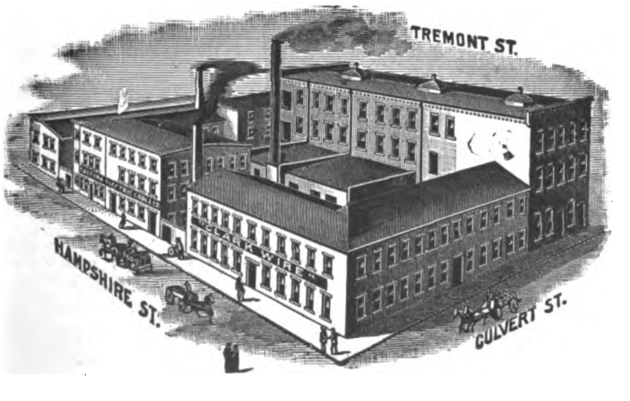
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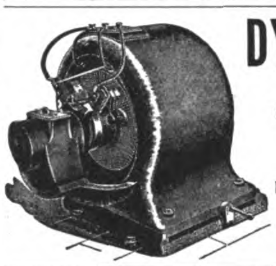

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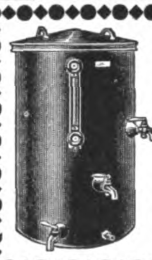

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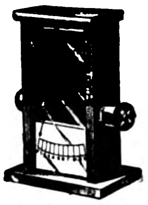

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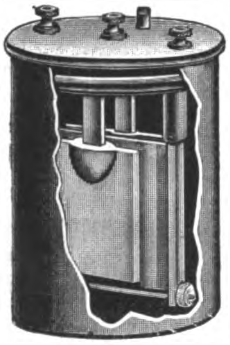

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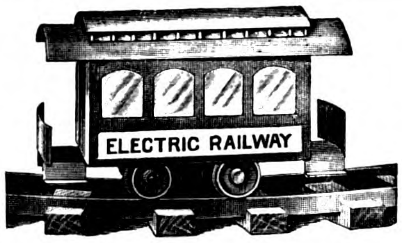

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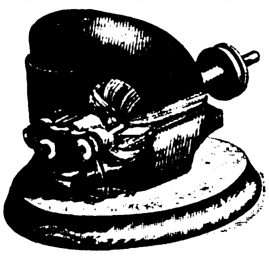

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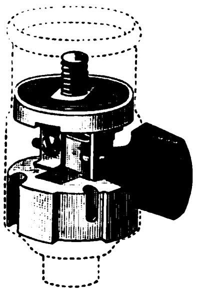

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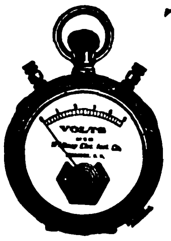

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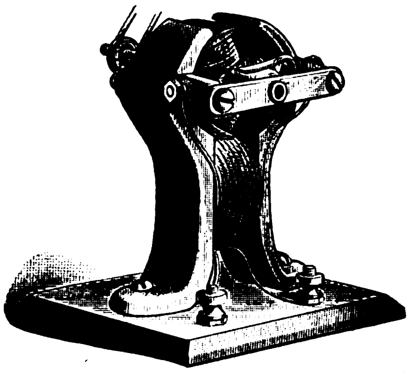

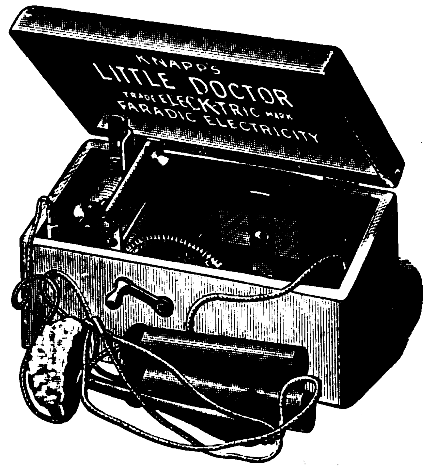

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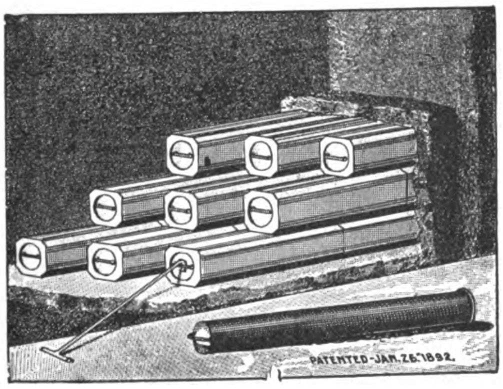

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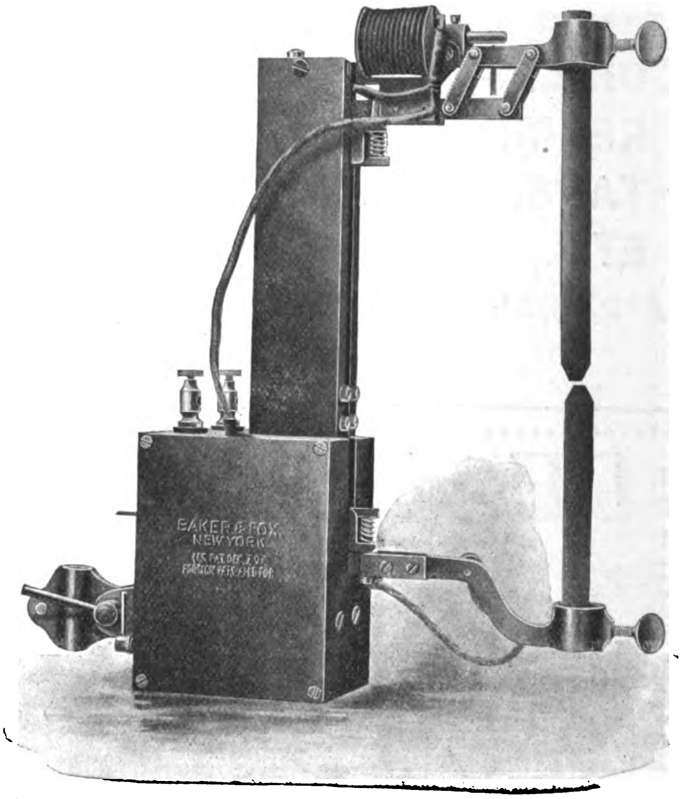

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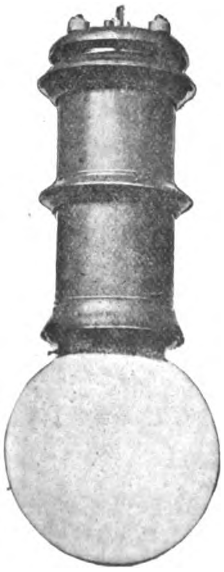

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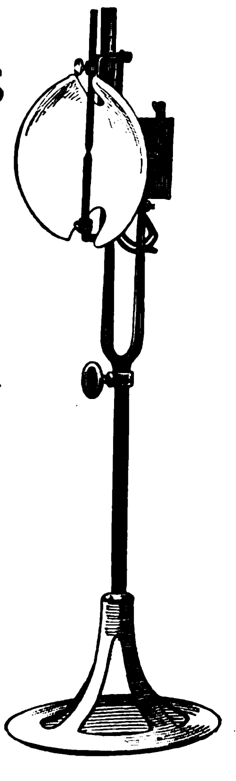

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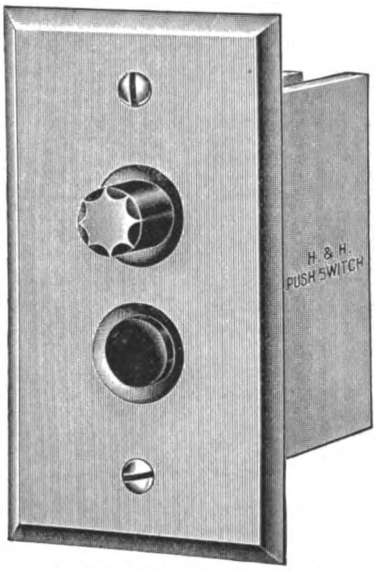

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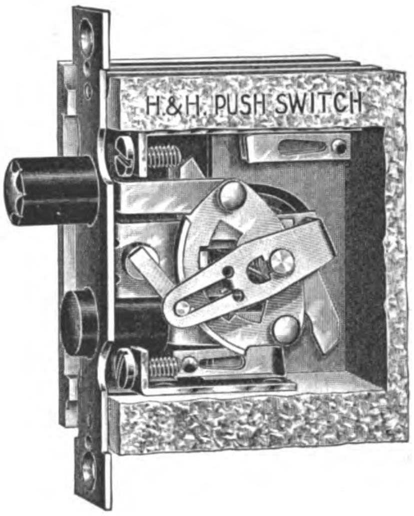

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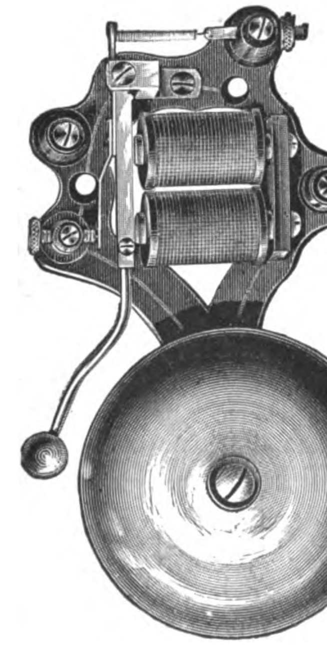

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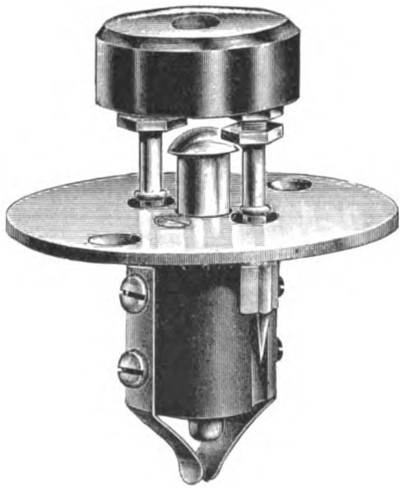

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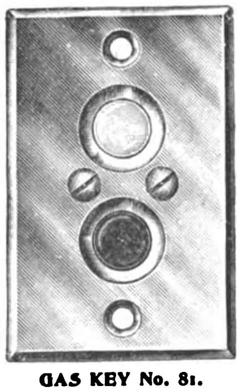

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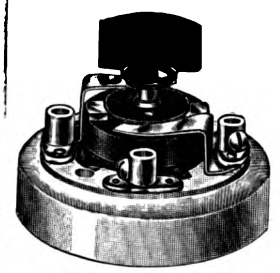

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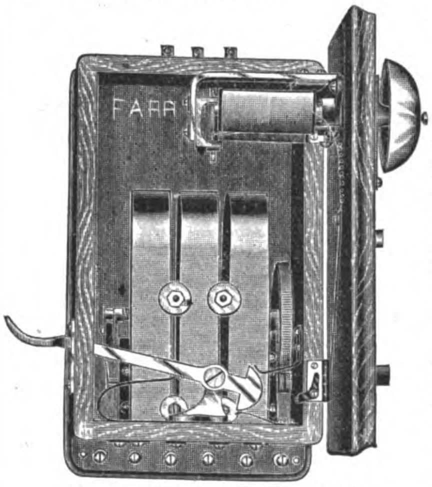

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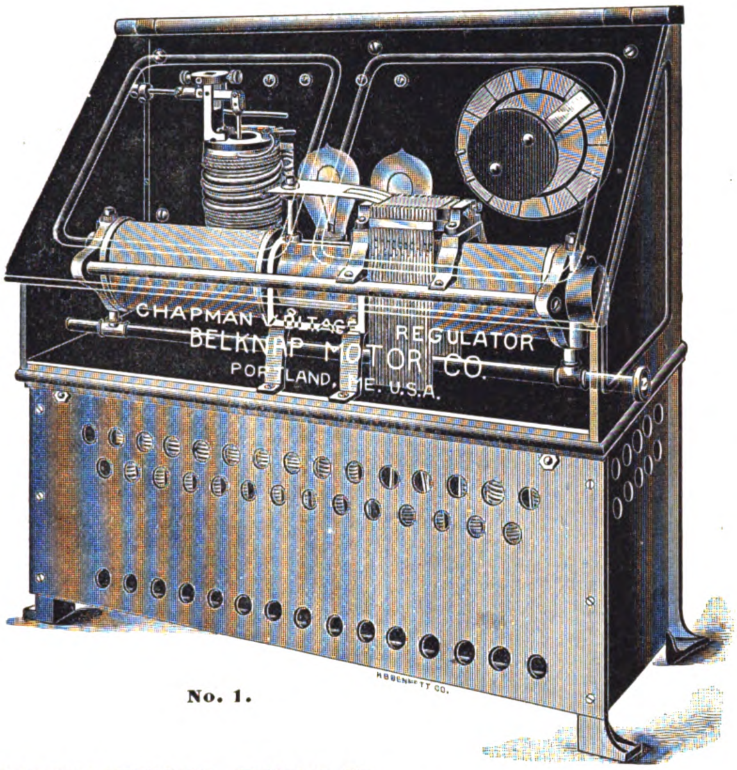

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You may enter our order for a Regulator for our K. W. T. H. Monocyclic Generator, as per our recent conversation. Yours very truly,

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What the Edison Electric Illuminating Co. say:

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Gentlemen:—In reply to your recent letter regarding Voltage Regulators can say we are very well satisfied with our purchase, and as for wanting additional regulators, will say the two we have regulate the fields of three pair of 45 k. u. Edison Machines, and when we require more than three engines on the bus bars we switch them in with the machines on the regulators and find we get very good results by using the hand rheostats to divide the load as we want it, your regulators keeping the voltage on all the machines constant within three volts.

As I say, we are well pleased with the regulators and could not be without them now we know their worth. Yours very truly,

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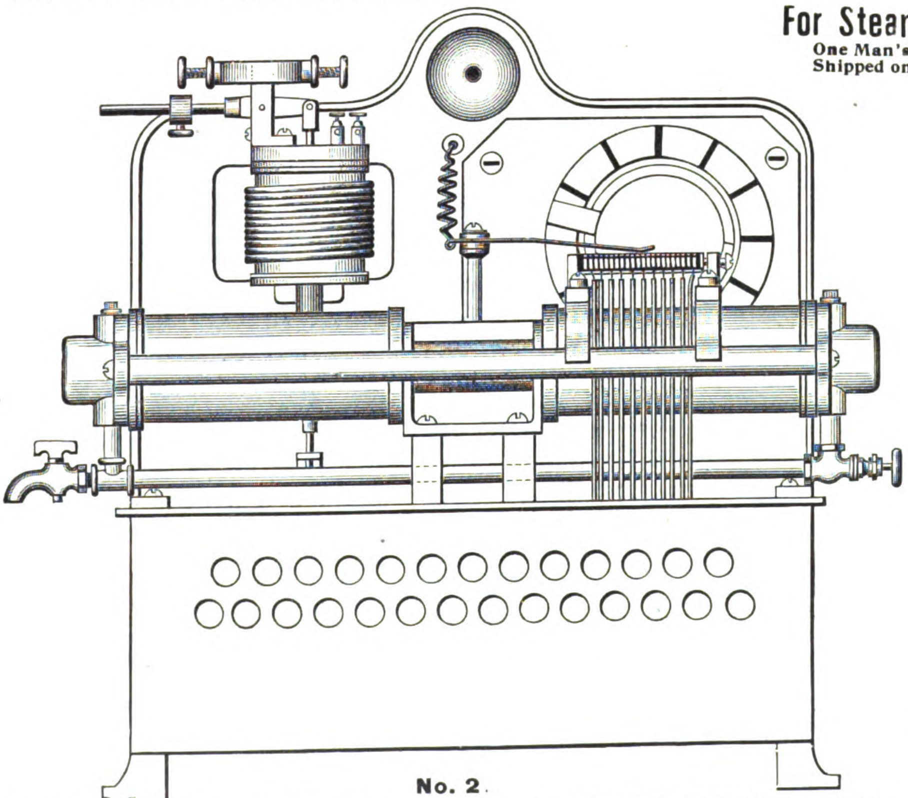

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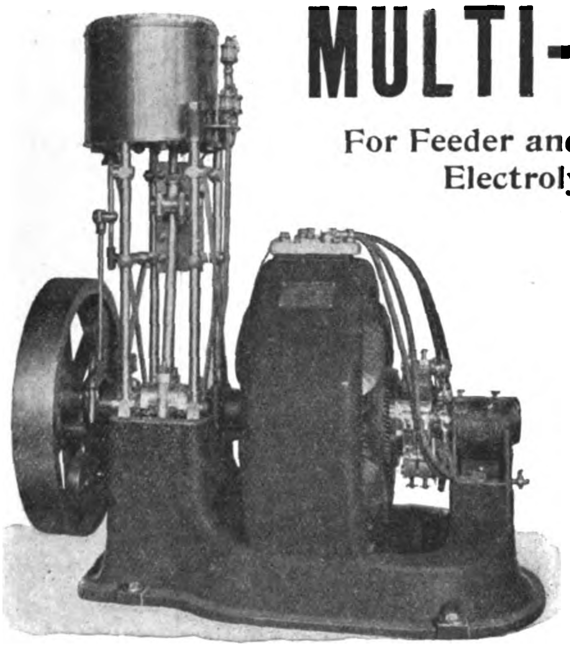

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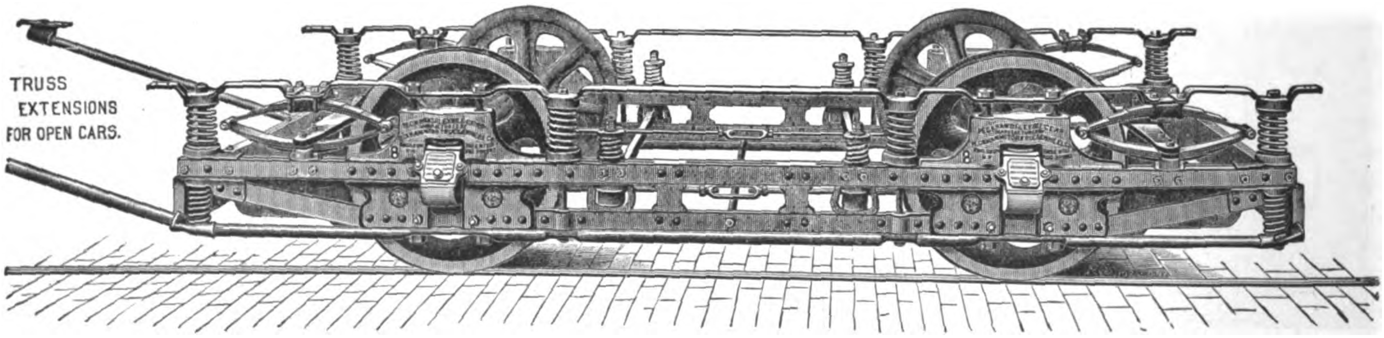

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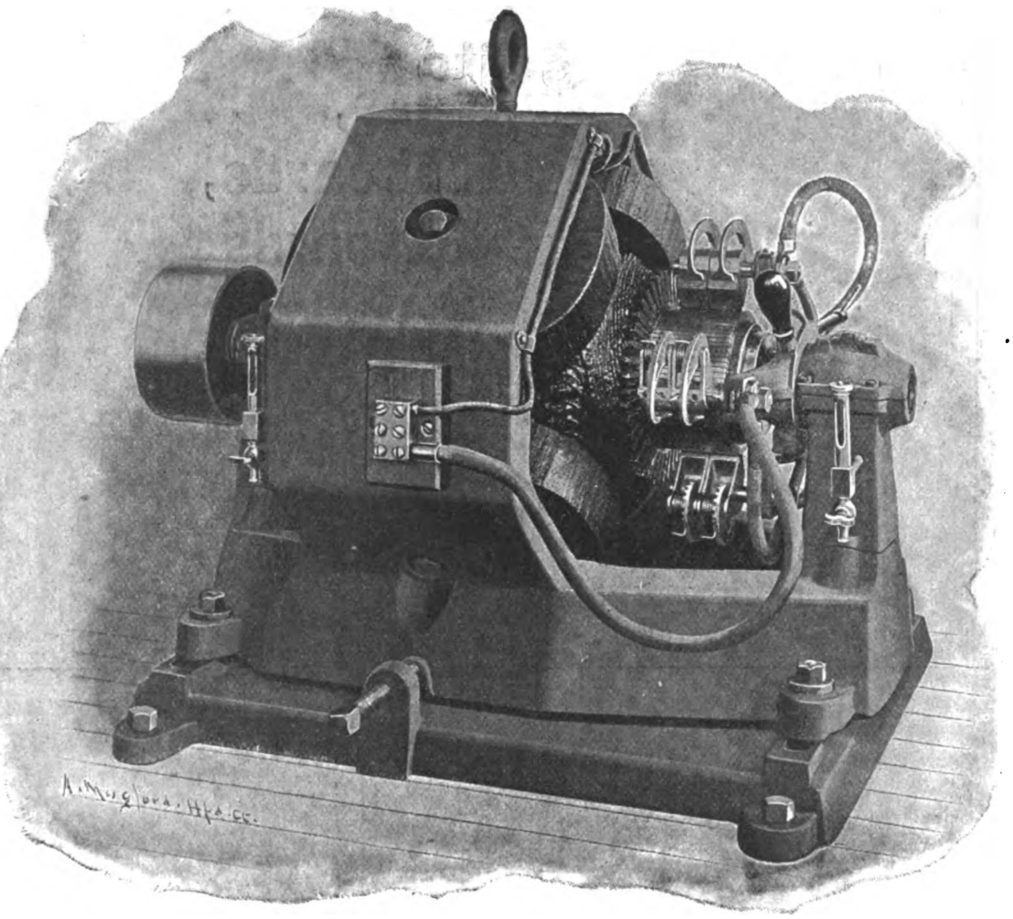

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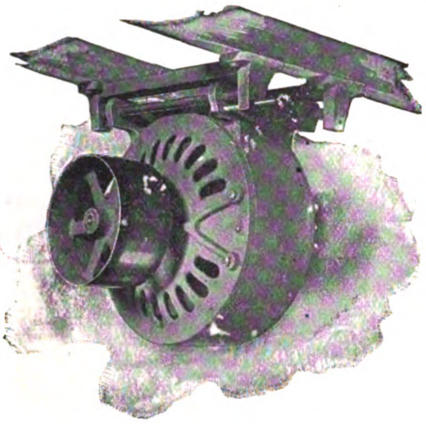

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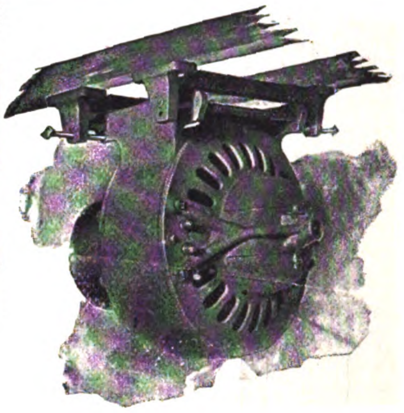

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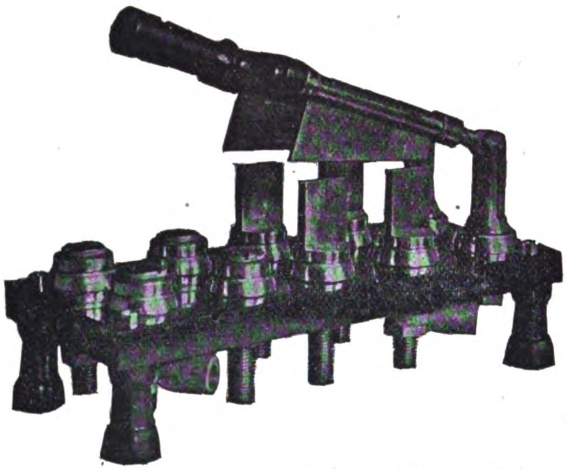

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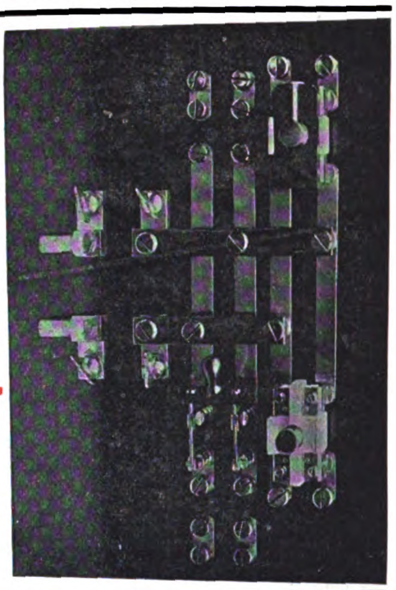

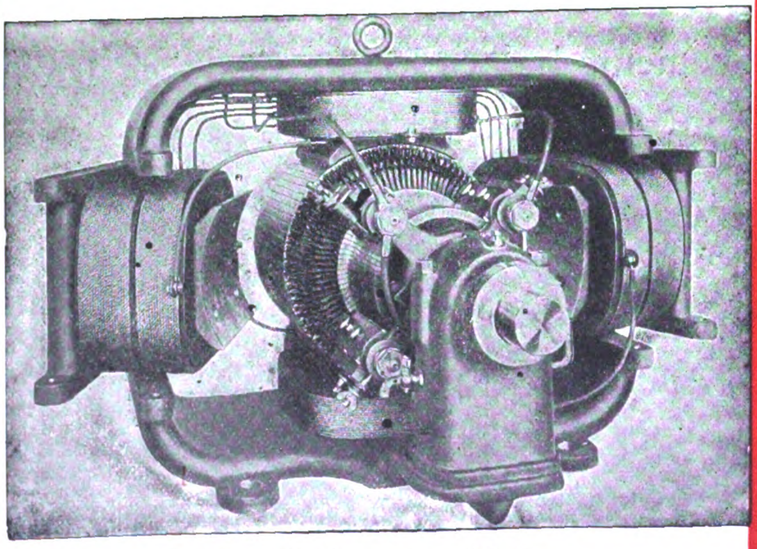

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Vol. X. New York, December, 1898. No. 12.

LONG DISTANCE ELECTRICAL TRANSMISSION OF STEAM POWER.

THE PLANT OF THE COLORADO ELECTRIC POWER COMPANY.

BY RALPH D. MERSHON.

THE Cripple Creek mining district, though not far from some of the best coal fields of Colorado, is about 5000 ft. higher than the most accessible of them. This lift of 5000 ft., making itself felt through the medium of freight rates, means high-priced fuel, and, in consequence, steam power is expensive, especially in the case of such intermittent work as hoisting, which constitutes the major portion of the work done in the mines. Another condition contributing toward a high average cost of power is the existence of numerous small users, for, although the large mines of the district consume much power, both for steady and intermittent work, there are many small mines and prospects whose aggregate power consumption equals or exceeds that of the large mines. For these reasons, in addition to the fact that many of the mines operate continuously, the Cripple Creek district furnishes a market especially favorable to the profitable transmission and distribution of power by electricity. Recognizing this fact, the late O. B. Shallenberger, of Rochester, Pa., and D. V. Donaldson, of Colorado Springs, undertook in the summer of 1897 the formation of the Colorado Electric Power Company, a company whose primary object was to supply power to "the greatest gold camp in the world." The brilliant reputation of the former of these men in electrical work and the confidence reposed in the latter by all who knew him, made the floating of the enterprise easier than is usually the case with such ventures, and in the fall of 1897 work was begun on a transmission plant which has now been in operation for some months, and which is one of the most complete of its kind in this country.

After careful consideration of water power for this work it had been decided that, in view of the existing irrigation rights on the streams within reach of the market and the large reservoirs which would be necessary in order not to interfere with these rights, it would be cheaper to generate power by steam than by water. A site for the power station was therefore chosen at Cañon City, Colo., a point offering many ad-

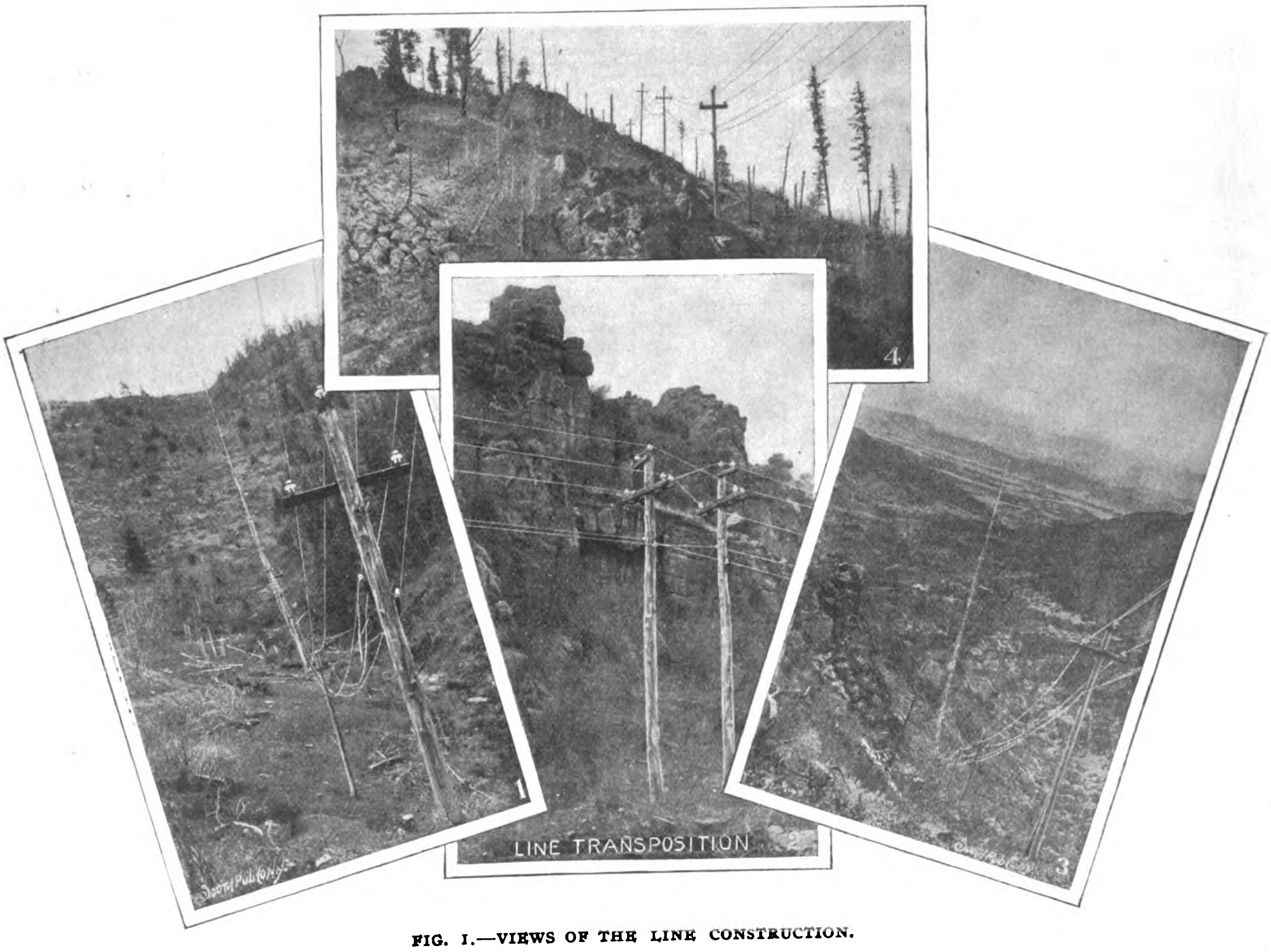

FIG. 1.—VIEWS OF THE LINE CONSTRUCTION.

vantages for the economical generation of power, chief among which is its nearness to the coal fields.

The station is located so as to be accessible from both of the railroads entering Cañon City; coal can be delivered from either of them on to a side track and unloaded thence directly into the coal bunkers. It is near the Arkansas River, from which water is taken for condensing purposes, and, if it should become necessary, coal may be delivered to it by a downhill wagon haul from the mines owned by the company.

The building is a substantial structure of brick and steel, and at present represents just half of what the completed structure will be, as both the building and equipment have been laid out with a view to an increase of capacity when business shall demand it, the increase to be made without interfering in any way with the operation of the plant. The general arrangement and dimensions of the building are shown in the ground plan, Fig. 2.

The fire-room equipment, shown in Figs. 3 and 4, consists of a battery of Heine water-tube boilers, manufactured by the Heine Safety Boiler Company, of St. Louis; the condensing apparatus, consisting of surface condensers with combined air and circulating pumps, made by the Snow Steam Pump Works, of Buffalo, N. Y.; Snow feed pumps; Wainwright corrugated tube heaters, made by the Taunton Locomotive Manufacturing Company, Taunton, Mass. The boilers, pumps and condensers have such a capacity and are so arranged that one unit is always idle as a reserve in case of emergency. The stack is of steel, guyed, and resting upon a substantial brick base. The water supply for the surface condensers is taken from the Arkansas River at a point about 400 feet above the station, and is brought by a wooden flume to the settling tank, whence it is drawn by the circulating pumps, sent through the condensers and discharged again into the river.

The steam equipment of the engine room consists of the three main engines, and two exciter engines. The main engines are Hamilton-Corliss cross compound condensing engines, with receiver and reheating coil, made by the Hooven, Owens & Rentschler Company, Hamilton, Ohio, They take steam at 125 lbs., and their speed is 100 r.p.m. Though they normally run condensing they may be run non-condensing in case of emergency, and will carry their load under those conditions. Each one is direct connected to a Westinghouse three-phase generator delivering current at 500 volts and 3600 alternations per minute, 30 cycles per second. The exciter engines are Westinghouse "Standard," running at 350 r.p.m. They take steam at the same pressure as the main engines and exhaust into the heaters, as do also the pumps in the fireroom. Each exciter engine is connected by means of a spring coupling to a Westinghouse 125-volt direct-current dynamo. Either of the exciter rigs is capable of exciting all of the main generators. The nominal rating of the main generators is 470 k.w each, but the specifications on them and the engines were such that the three generating units are together capable of delivering something over 2000 h.p. In operation, one of the main generators will be kept idle as an emergency reserve.

The current from the main generators and exciters is carried by cables in tunnels under the station floor, each to its own switchboard. The exciter switchboard is of the Westinghouse standard type, consisting of two marble panels—one for each exciter—on which are mounted the usual instruments and switches. The main switchboard has four panels—three generator panels and one load panel. Each generator panel has besides the usual field plugs, rheostat and main switch, three ammeters, one for each machine lead, and two Shallenberger indicating wattmeters, the sum of whose reading gives the output of the generator.

The load panel has three ammeters and two wattmeters. The sum of the watt-

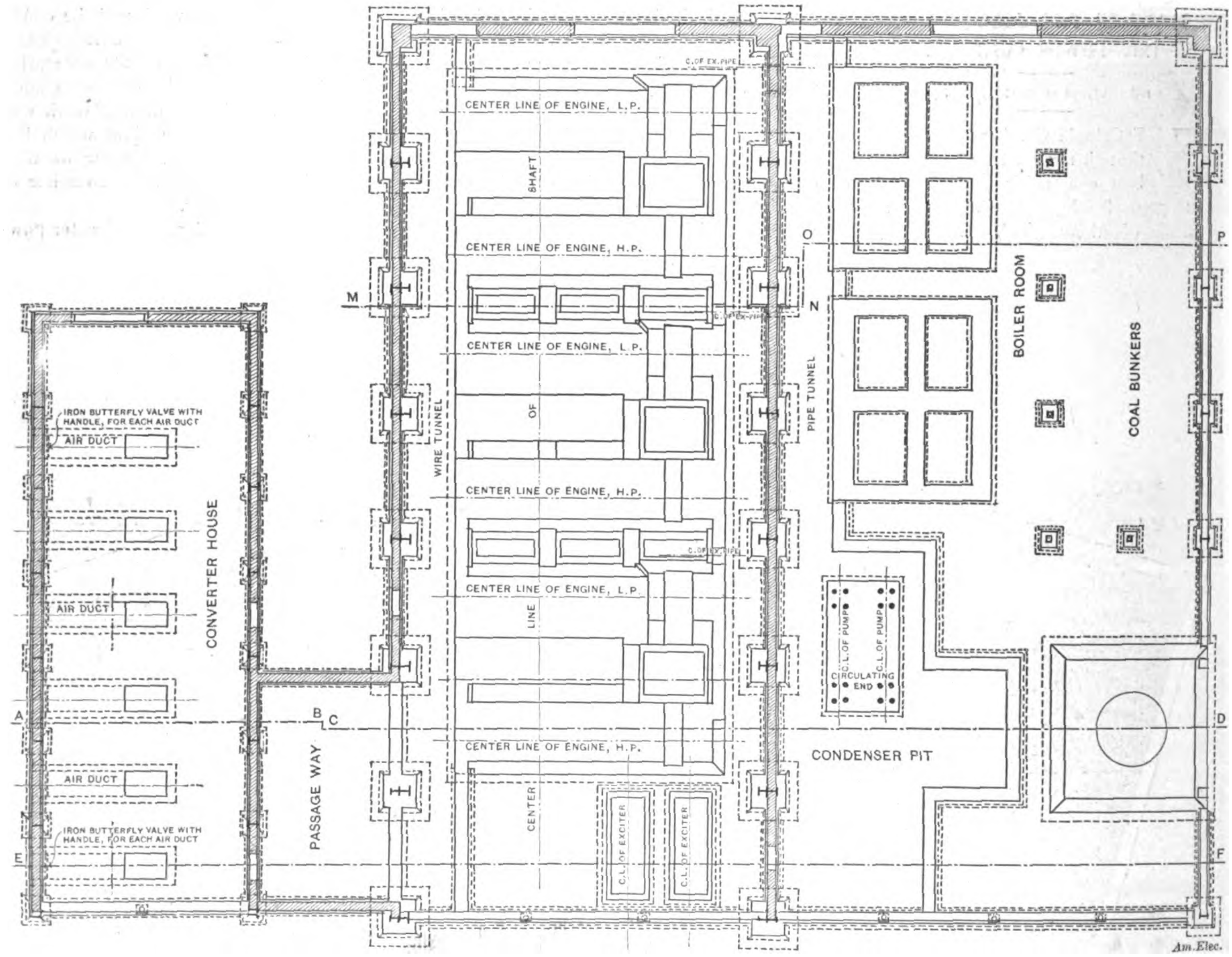
C. OF EX. PIPE
CENTER LINE OF ENGINE, L.P.
SHAFT
CENTER LINE OF ENGINE, H.P.
M
N
O
P
CENTER LINE OF ENGINE, L.P.
BOILER ROOM
COAL BUNKERS
PIPE TUNNEL
WIRE TUNNEL
OF
CENTER LINE OF ENGINE, H.P.
IRON BUTTERFLY VALVE WITH HANDLE, FOR EACH AIR DUCT
AIR DUCT
AIR DUCT
CONVERTER HOUSE
CENTER LINE OF ENGINE, L.P.
LINE
C.L. OF PUMPS
C.L. OF PUMPS
CIRCULATING END
A
B
C
D
CENTER LINE OF ENGINE, H.P.
CONDENSER PIT
PASSAGE WAY
CENTER
AIR DUCT
IRON BUTTERFLY VALVE WITH HANDLE, FOR EACH AIR DUCT
E
F
C.L. OF EXCITER
C.L. OF EXCITER
Am. Elec.

FIG 2.—GROUND PLAN OF POWER HOUSE.

meter readings is the total output of the bus bars. The ammeters, however, do not indicate the bus bar currents; each measures the current to one of the three step-up transformers, and is thus a ready means of detecting and locating any incipient trouble in the transformers or any unbalancing of the load. The additional instruments are three voltmeters and a synchroscope mounted as an arm at one end of the board so as to be visible from each panel. The synchroscope can by means of plugs be used for synchronizing any machine with the bus bars. One of the voltmeters can be plugged on to any phase of any machine.

Of the remaining two voltmeters one at all times indicates the voltage of the bus bars; the other in connection with a compensator indicates at all times the voltage on the secondary distribution circuits at Cripple Creek, and thus enables the station attendant to hold the distribution voltage at any desired value.

None of the instruments on the board carry the main current; they receive current from the secondaries of series transformers, whose primaries are in the main leads. These series transformers are mounted upon a rack behind the switchboard. As will be seen from the illustrations, there has been left between the main switchboard and the exciter board a space for additional panels, when the plant shall be extended. Mounted upon a mahogany panel, which will form a part of the completed switchboard, are a steam gage, vacuum gage and recording pressure gage, this arrangement bringing the operation of both the steam and electrical machinery under observation at one place.

The connections of the wattmeters are shown in Fig. 10. 1, 2 and 3 may represent either the three bus-bars or the three leads of any machine. A and B are the two indicating wattmeters. S, S, S, are series transformers, each included in one of the three leads. C is a single coil shunt trans-

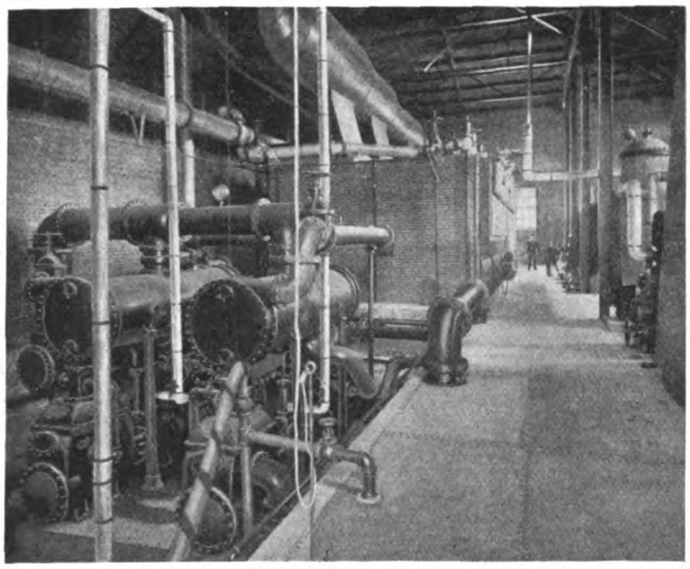

FIG. 3.—COMBINED AIR AND CIRCULATING PUMPS.

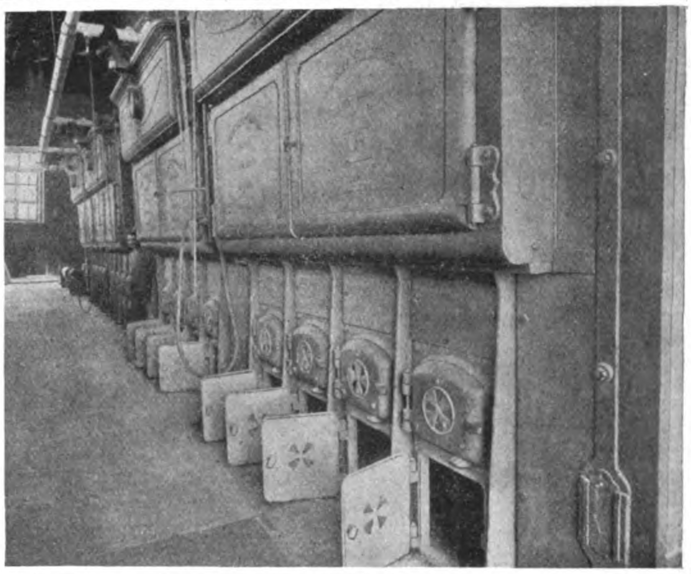

FIG. 4.—THE BOILER PLANT.

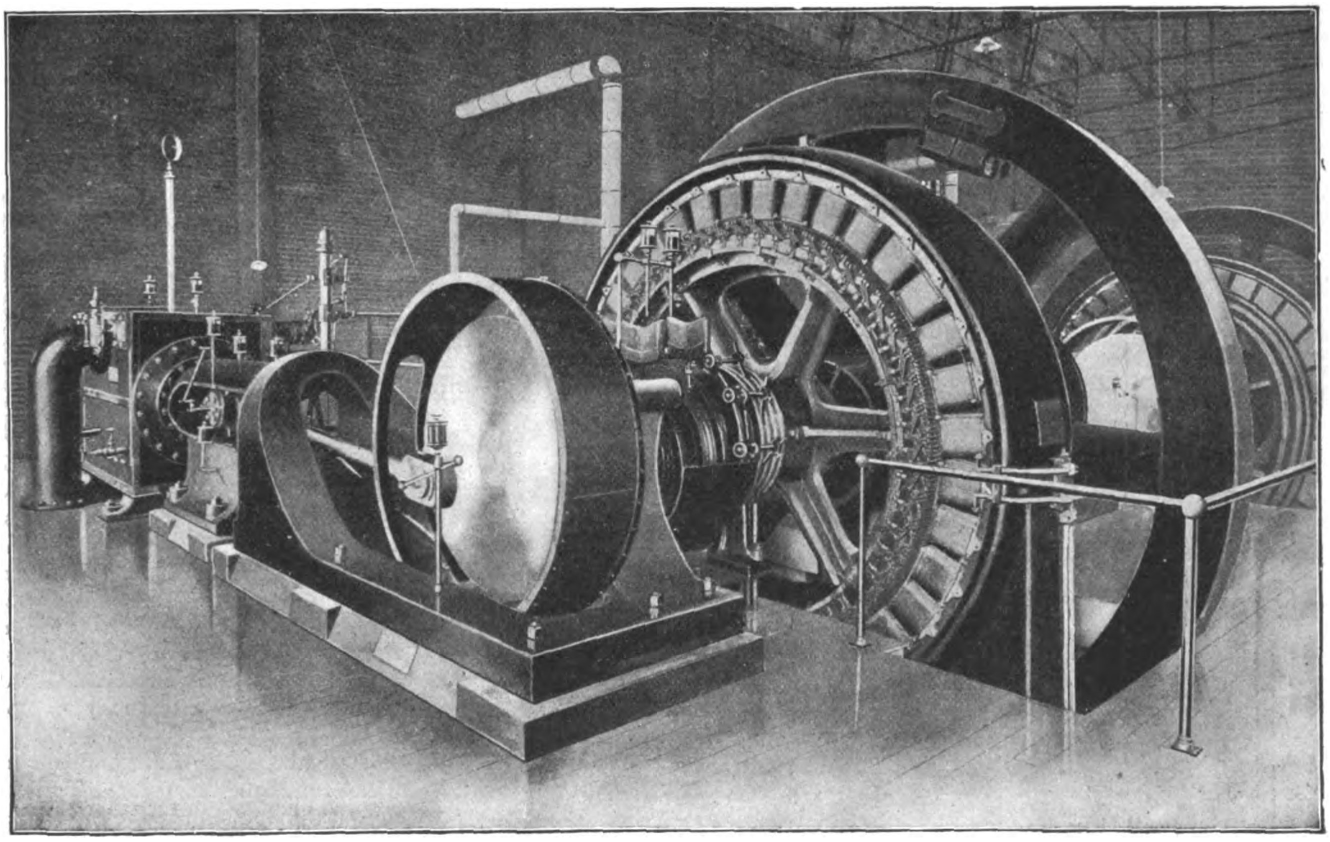

FIG. 5.—ONE OF THE MAIN UNITS.

former having a terminal brought out at its middle point. As will be seen from the diagram, the wattmeter, A, receives the current for its series coil from the series transformer in the lead, 1, while its voltage coil is connected from lead No. 1 to the middle point of the single coil transformer C. Wattmeter B receives for its series coil a current which is a resultant obtained from the two series transformers in leads 2 and 3. Its voltage coil is connected between the leads 2 and 3.

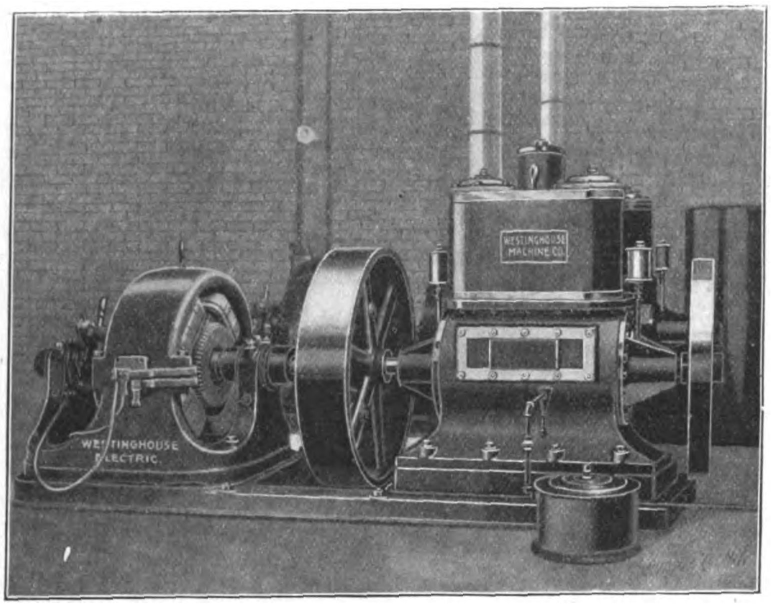

FIG. 6.—AN EXCITER SET.

From the switchboard the current goes overhead to the step-up transformer house. The cables carrying it are brought down along the wall of this building to the transformer switches, which are mounted upon the wall opposite their respective transformers. From the switches cables go under the floor to the transformer foundations and pass up through them to the transformers.

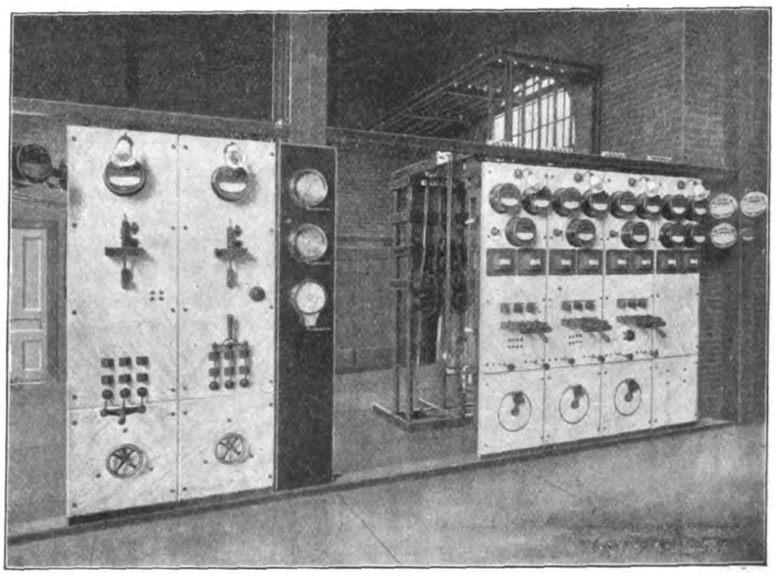

FIG. 7.—THE SWITCHBOARDS.

The step-up transformers are four in number, one being always idle as a reserve. They are the Westinghouse self-cooling oil transformers, the tanks containing them being made of sheet iron and with a number of corrugations for obtaining the necessary radiating surface. They raise the voltage from 500 to 21,000 volts. Both the high and low-voltage coils of the three transformers in service are connected in delta, so that one transformer may at any time be cut out without interfering with the running of the plant. This allows a damaged transformer to be replaced by the reserve transformer without interrupting the service, an advantage which the Y-system of connection lacks. The arrangements for throwing in the relay to replace one of the transformers in service are simple, and such that the substitution can be made in a few minutes. It is accomplished on the low-voltage side by means of a pair of relay cables and double throw, double pole switches for each of the three transformers normally in service; on the high-voltage side by means of double pole circuit breakers, of which there is one for each transformer, and long-handled plugs, by means of which the relay is plugged onto the proper pair of 20,000-volt bus bars.

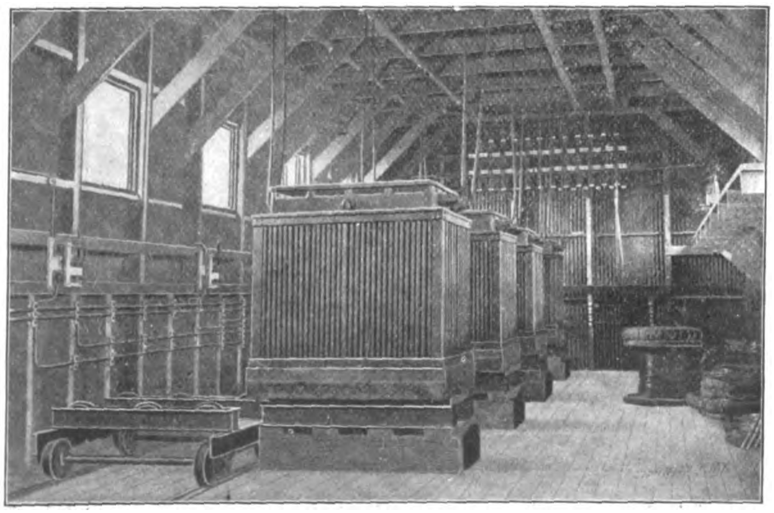

FIG. 8.—STEP-DOWN TRANSFORMERS AND TRUCKS FOR HANDLING.

In addition to a hand-tripping device the high-voltage circuit breakers are arranged to open automatically whenever energy passes through them in the wrong direction; that is, whenever a transformer becomes disabled its circuit-breaker will disconnect it from the 20,000 volt bus bars. Any trouble in a transformer which will cause its high-voltage circuit breaker to open will also blow the fuses in its low-voltage leads. The result is that a damaged transformer is automatically cut out. Two of the raising transformers are capable of carrying the full output of the station indefinitely, so that as far as continuity of service is concerned there is a reserve transformer capacity of 100 per cent.

From the 20,000-volt terminals of the transformer the current is led straight up to the high-voltage circuit breakers, and from there to the high-voltage bus bars. Both the circuit breakers and the bus bars are carried up on a wooden rack overhead—everything out of reach, with the exception of the insulated handles for operating the circuit breakers. On this same rack are mounted the plugs and sockets for switching the 20,000-volt end of the relay transformer. From the bus bars the

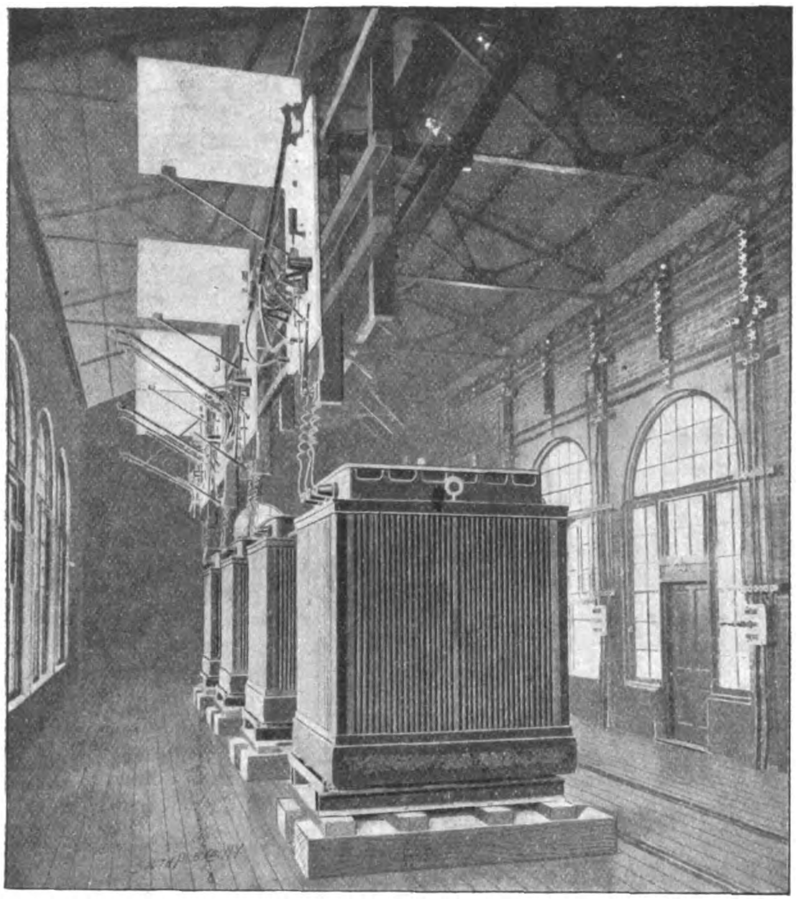

FIG. 9.—STEP-UP TRANSFORMER BANK AT STATION.

current passes at 20,000 volts through the main plugs for disconnecting the main line from the high voltage bus-bars, main fuses and choke coils, which, in connection with a bank of Wurts non-arcing arresters, protect the station from lightning discharges. All this apparatus is overhead. From the choke coils the three 20,000-volt leads pass through glass tubes in the end of the building to the transmission line.

It will be noted that all the low voltage mains and switches are confined to one side of the building, while the high-voltage apparatus is all on the other side, overhead, and out of reach.

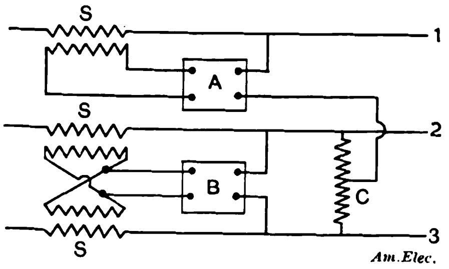

FIG. 10.—WATTMETER CONNECTIONS.

The method of handling the transformers is worthy of note. Each transformer tank has fastened to the bottom of its cast-iron base two bars of iron which serve as rails. These rails each rest upon three flanged wheels, free to revolve when the transformer is pushed along over them, but not free to change their positions, since the pins upon which they revolve are held between two pieces of channel iron which are fastened down to the transformer foundations. These wheels thus held form a mounting exactly similar to that shown on the truck in Fig. 8, When it is desired to take one of the transformers out of its tank the truck mentioned above is rolled along upon its track until the mounting upon it is opposite that under the transformer base. The transformer is then pushed off of its mounting onto that on the truck. The truck, with its load, is then rolled to one end of the building, and under an I-beam, to which chain blocks are attached and the transformer raised from its tank. This method of handling is a convenient one, and besides being cheaper than an overhead crane, there is no danger from nor interference with the overhead wires.

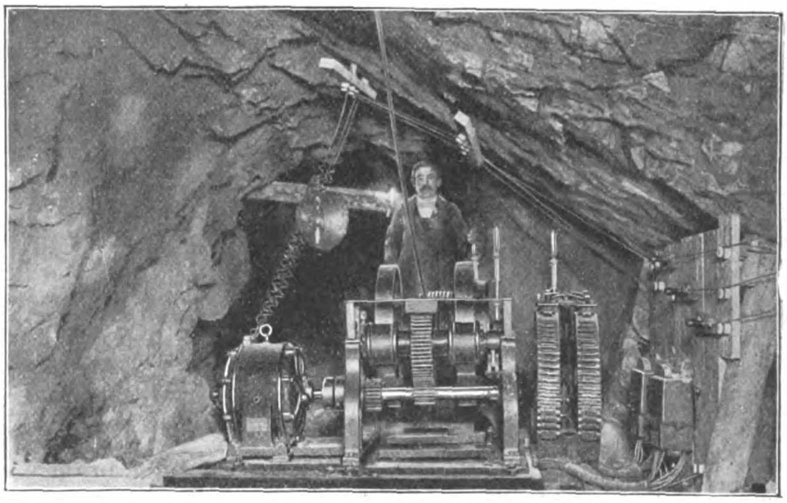

FIG. 11.—MINING HOIST.

The transformer foundations, instead of being solid, consist each of two brick piers. On each pier is set one of the mountings above described. The space between the piers connects, by means of a tunnel, with the outside of the building. Thus there is at all times supplied to the transformer a current of cool air which, on becoming heated, passes up through the ventilator in the roof of the building and carries with it any fumes there may be from the oil. The transformer fuse blocks are located below the transformer, between the piers above mentioned. Here they are out of the way, but easily accessible.

The transmission line extends from Cañon City to the heart of the Cripple Creek mining district, its length being a little under twenty-five miles. In part it passes over rolling park land where construction is easy. On other portions of the line construction is exceedingly difficult, not only because of the amount of blasting necessary, but also on account of the difficulty of delivering material. The accompanying illustrations of the more rugged portions of the line do not convey an adequate idea of their steepness and roughness.

The power line consists of three No. 3 bare copper wires arranged in a triangle, one wire being at the top of the pole. The wires are carried on glass insulators that are especially designed for the voltage at which the plant is operated. The insulator pins and cross-arms have been specially treated to preserve their insulating qualities and protect them from the weather. The two wires of a telephone circuit are carried upon bracket pins below the power wires, and by careful attention to transposition the telephone service has been made perfectly satisfactory and safe.

The poles are white cedar, the standard length being 30 ft., although some are of necessity considerably longer. The triangle formed by the power wires is not quite an equilateral one, and for this reason the power wires are transposed twice in the length of the line. All angle poles have double cross-arms and fixtures and are substantially braced. All spans longer than the standard length (125 ft.) have double poles on each side of them, each pole having double cross-arms and fixtures.

In addition to the lightning protection at each end of the line, in the power station and receiving station, there are Wurts lightning arresters installed at four intermediate points on the line.

At present there is one receiving station at Cripple Creek; another is in course of erection. Here the current is transformed from 20,000 to 500 volts, and distribution is made at the latter voltage. The arrangement of the apparatus in the substation is in general similar to that in the transformer house at the power station, about the only difference being that here the circuit breakers for automatically cutting out a disabled transformer are in the low-voltage circuit, and the transformer fuses in the high-voltage circuit.

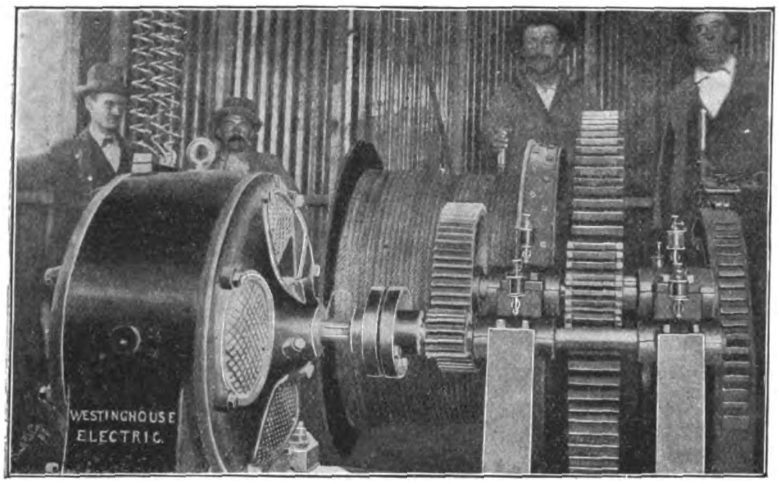

FIG. 12.—MOTOR AND GEARS OF ONE OF THE HOISTS.

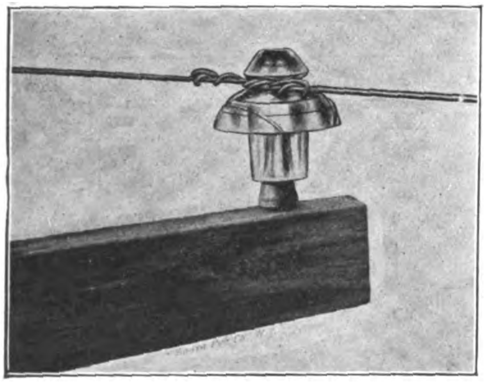

FIG. 13.—ONE OF THE 20,000-VOLT INSULATORS.

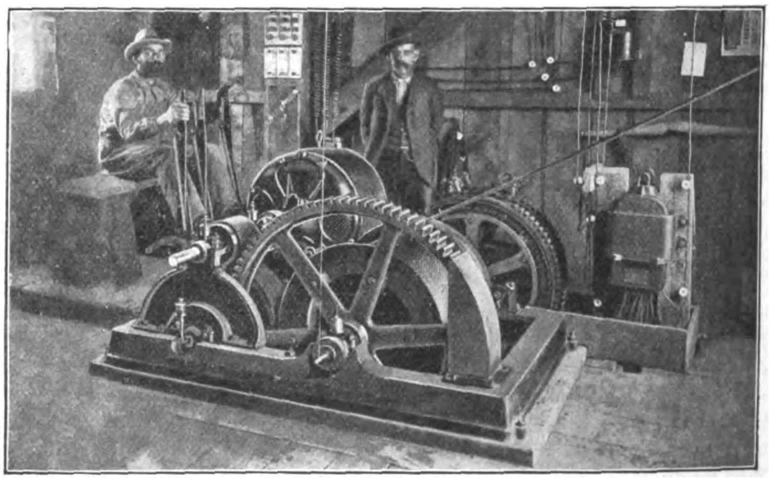

FIG. 14.—TYPE OF MINING HOIST.

So far only hoists are being operated, though a number of motors are being installed for driving mills, pumps and compressors. Some of the hoists are illustrated in Figs. 11 to 13. They are driven by means of Westinghouse three-phase induction motors, whose speed is controlled by means of auto-converters in connection with a commutator type controller. The method of handling these hoists is as simple as that of the steam hoists which they replace, and the men who run the latter find no trouble in operating the electric hoist. The starting of the electric hoist is more gradual and the running smoother than the steam hoist. There is no boiler to fire and keep in repair and no coal and water to look after. Of the hoists illustrated in this article, those in Figs. 13 and 14 were supplied by the Stearns-Roger Mfg. Co., of Denver, and that in Fig. 11 by the Hendrie, Bolthoff Mfg. Co., Denver, all being operated by Westinghouse induction motors.

The cost of power in the Cripple Creek district when generated by steam is high, not only because of the price which must be paid for coal, but because in most cases water for the boilers must be hauled by wagon from some distance and up steep grades. In some cases the cost of water for the boilers equals that of the fuel. Power is being supplied by the Colorado Electric Power Company at a price considerably less than the cost when steam is used, especially in the case of small plants. This, in connection with the advantage of greater flexibility and ease of operation, creates a steady demand for electric power which is being filled as rapidly as motors can be obtained. It bids fair to be but a short time until the present plant is loaded to its full capacity.

TWO-RATE METERING.

BY LYMAN C. REED.

The subject of two-rate metering is one which admits of many aspects. The following arrangement of arriving at a mode of two-rate metering is one which it is hoped will interest those seeking a solution of the problem without the employment of a clock mechanism. In all meters of the mechanical or motor type the power factor necessarily forms one of the main objects of consideration in the accurate measurement of current. The present article does not presume to deal with all the meters of the motor form, but taking the Thomson wattmeter as a fair sample of the type, we will proceed to give a description of a new and perhaps interesting departure in meter practice.

One of the problems which confronts all central station managers is the correct metering of current sold by them to consumers. That this is a consummation which is far from being realized is granted. For instance, we will take as an illustration the case of a large store or dwelling, in which we will say there are installed 400 to 500 lights. As the maximum number of lights is turned on occasionally, it is necessary to put in a meter of capacity large enough to carry the full load. Under circumstances such as these, when a few lights are turned on, the consumer pays only a nominal amount for them, as meters of large capacity are very inefficient on small loads. To remedy this trouble and also to furnish a basis of two-rate charging for current, the system as shown in diagram is found to operate successfully. On the three-wire low-potential direct-current system, carrying 115 volts on a side, a meter of 100-ampere capacity would be put in on an installation of from 400 to 500 lights. This meter, adjusted to run correctly, on full load, will, on loads of from 1 to 10 per cent of the maximum, register far below what it should.

A carefully conducted test on a meter of 100 amperes capacity in series with a 7½-ampere meter with a variable load of from one to ten lights, showed a difference of 30 per cent in the amount registered, in favor of the small meter. This experiment led up to a solution of the problem by placing two meters in parallel, having the load on each controlled by an automatic switch of simple design.

The diagram shows a 7½-ampere meter in parallel with a 100-ampere meter, both meters being in connection with the switch as shown. The switch consists of a double-wound solenoid, each coil being respectively in series with the fields of the small meter, but of sufficient capacity to carry the full load of the installation. The pull of the solenoid on the iron armature is balanced by an adjustable weight placed on the other end of the lever, and permitting of being set to cut in the larger meter at any desired load. On the other end of the lever are mounted contact points which plunge into mercury wells when the switch operates to cut in the large meter. We will assume the switch to be regulated for a load of 10 amperes on a side; then, for all loads under this amount, the small meter is the only one in circuit. When the load reaches 10 amperes the armature is pulled down and plunges the contacts into the mercury wells, thereby putting the large meter in parallel with the smaller. The fields of the small meter have approximately twelve times as much resistance as the larger meter, the current divides itself accordingly, and the large meter receives 9.15 amperes and the smaller .85 ampere. As the load increases the ratio remains the same, and both meters are working under the same percentage of load with respect to their rated capacity. The small amount of day burning and the number of lights left on all night after the store closes, are under the present system of measurement practically lost to the central station, while the system described above registers accurately all current consumed.

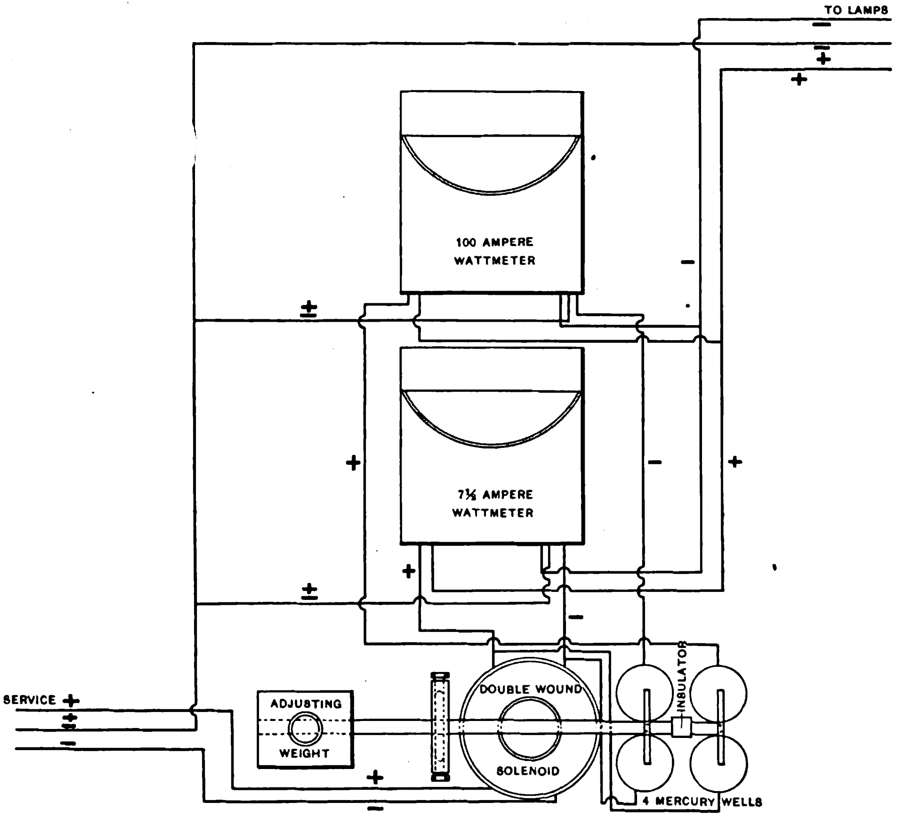

FIG. 14.—METHOD OF CONNECTION FOR TWO-RATE METERING.

The feature which presents itself as an outcome of this parallel metering, and on which we wish to dwell at more length, is that it affords a solution of selling current at two rates. The small and long-hour burning would be registered on the small meter, the short heavy-hour burning on the large and small together, but as the ratio is fixed between the two, this fixed percentage would be deducted from the register of the small meter and added to the register of the large meter, in order to keep the large and small consumption entirely distinct. Under the usual conditions prevailing in general private lighting, the heavy load would be carried from about 5 to 10 P. M. There are some rare cases where the day load would be the heavy load and, of course, the rate in that case could be adjusted to suit the customer.

The usual method of charging on the two-rate system where a clock is used for switching over at fixed periods, admits of the serious objection of not meeting the requirements for which two rates are given. It has been found by careful investigation that current can be sold more cheaply at the same profit at different periods of the day. When the peak of the load is on and the station is strained to its utmost to meet the demand, the conditions of economical running-are not as favorable as under normal load, and hence it is considered good practice to encourage day burning by giving a cheaper rate, from, we will say, 10 P. M. at night until 5 P. M. the next day. Now, when a sudden rain storm comes up in the daytime, and in a few minutes the plant is compelled to put out an enormous increase of current, the conditions for economical running are very adverse, and should be met in some way. It will be seen that under these conditions the automatic switches would cut in the large meters, whose registers are charged for at the higher rates, thus affording compensation for the additional operating expenses at the plant.

The installing of two-rate meters on very small consumers is out of the question as an economic practice, as the first cost and maintenance of the meter is too great. The same consideration would apply to the arrangement just shown, and would only be practicable with the large consumers. The cost of installing two meters and an automatic switch, as shown, is less than the two-rate meter, and we think has points of advantage which make it well worth consideration. It does away with all troubles relative to clock mechanism, is entirely automatic in action, takes care of all sudden increase in load, and affords a much more perfect method of registering current consumed. Anything which adds to the accuracy sought leads to further development, and encourages the belief that at no distant day the much vexed question of how to meter correctly will be solved.

The Electric Plant of the Battleship "Oregon."

ELECTRICAL EQUIPMENT OF THE U. S. BATTLESHIP "OREGON."

BY ALEX. J. DICKIE.

To the mind of the layman, the term "battleship" brings a very vague impression. Even seen through the eyes of many of "our special artists," the modern man of war presents a most grotesque spectacle.

It might be well, then, before entering into a detailed description of her electrical equipment, that we show the reader just what this ship, the "Oregon," is.

In the Naval Annual she is described as a first class coast line battleship. She is first class in that she is formidable enough to fight with the best ships afloat; coast line, in that she has low freeboard, and is not specially designed for sea-going qualities; battleship, in that her business is fighting.

All modern battleships are in the nature of a central, heavily armored citadel, with a ship built around it. The citadel contains the fighting material. The ship serves to float the citadel, and also to house the officers and crew, and the various stores. In the "Oregon," the ship body is 348 ft. long, 69 ft. wide, and has a draft of 24 ft. The citadel is about 200 ft. long, and about 69 ft. wide. The weight of the whole is about 10,200 tons. The citadel and its turrets and watch tower are heavily armored. The rest of the ship is not. Within the citadel are the engine and boiler rooms, the dynamo room, the magazines, and all the heavier guns.

The engines of the "Oregon" are triple expansion, developing 11,000 h.p., and on her trial they drove the huge hull through the water at the rate of 16.68 knots per hour.

Her armament consists of four 13-inch breech loading rifles; eight 8-inch breech loading rifles, and four 6-inch. Besides these there are twenty-eight rapid-fire guns of different calibres, and six torpedo tubes. The 13-inch guns are contained in two turrets, one at each end of the citadel.

The magazines, handling rooms and engines for turning these turrets are located directly beneath them, when practicable.

Such, in brief summary, are the salient features of ships of the "Oregon" type.

The dynamo room, in which the power for lighting this ship is located, lies almost in the center of the citadel. It is just between the forward and aft main boiler rooms, and immediately beneath the auxiliary boiler room. One would think this a pretty hot place for such work, but, thanks to the efficient system of ventilation, the boiler rooms are comparatively cool on this vessel.

The generating plant consists of three General Electric generators, of 224 k.w. capacity, direct-connected to Union Iron Works' upright compound engines, running at 400 r.p.m. These generators supply 300 amperes apiece, at 80 volts. They are of the same type as all navy machines—four-pole, cross-connected, and compound wound for constant potential.

The bed plate for the engine and dynamo is cast in one piece. The commutator has to be made very large on account of the small rise in temperature allowed by navy specifications.

The switchboard and the various circuits for the distribution of this current conform to the naval standard.

There are in all 500 incandescent lamps to supply, of 10, 16, and 32 c.p., four searchlights, a complete signal apparatus, two stationary and four portable fan motors, and four motors for the 8-in. ammunition hoists.

The signal apparatus consists of five double signal lanterns, their cable connections and a keyboard for their operation. The lanterns are in halves, each half being fitted with a Fresnal lens; the upper half is red, the lower half clear. The signals are made by combinations of these lanterns. Sixty-two of these combinations are used, and each one is accomplished by a single motion of a key. Both lanterns and keyboard are water tight.

On the "Oregon" the signal lanterns are arranged along a back-stay, which is stretched between the signal yard and the center of the port forward 8-in. turret. There are four lanterns seized to the backstay, the masthead light forming the fifth of the signal set. The lanterns are spaced 12 ft. apart. There are two 32-c.p. lamps to each lantern. The cable connecting these lamps with the manipulator consists of 11 insulated copper conductors, of which one forms a common return for the two lamps. This cable is carried inside the military mast until a point is reached above the upper military top. From thence to the masthead it is carried by the backstay seized to the same, above and below each lantern. At each lantern two of the wires forming the cable are left out and connected to the proper lamp, and a branch from the common return is connected to each lamp; thus we have four wires entering into each lantern.

The keyboard, which is the most ingenious part of this system of signals, consists of a circular water-tight box. On the top of this box there is an annular

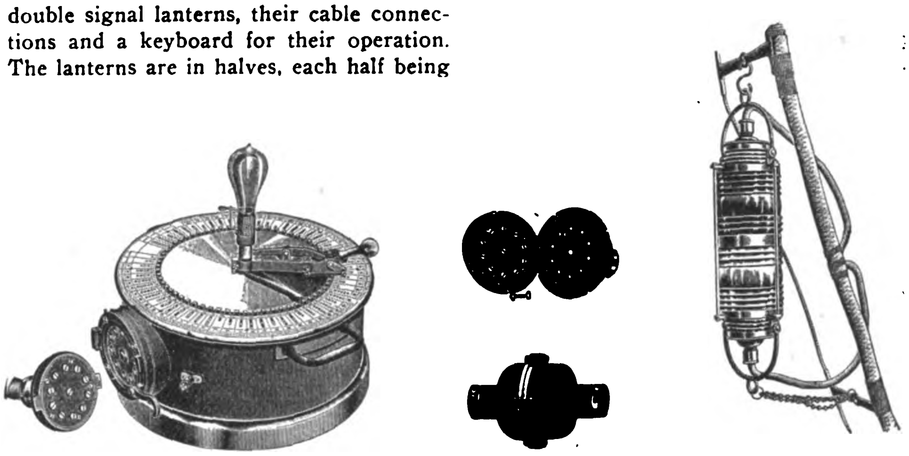

FIG. 2.—ARDOIS SIGNAL LAMP, KEYBOARD AND COUPLING.

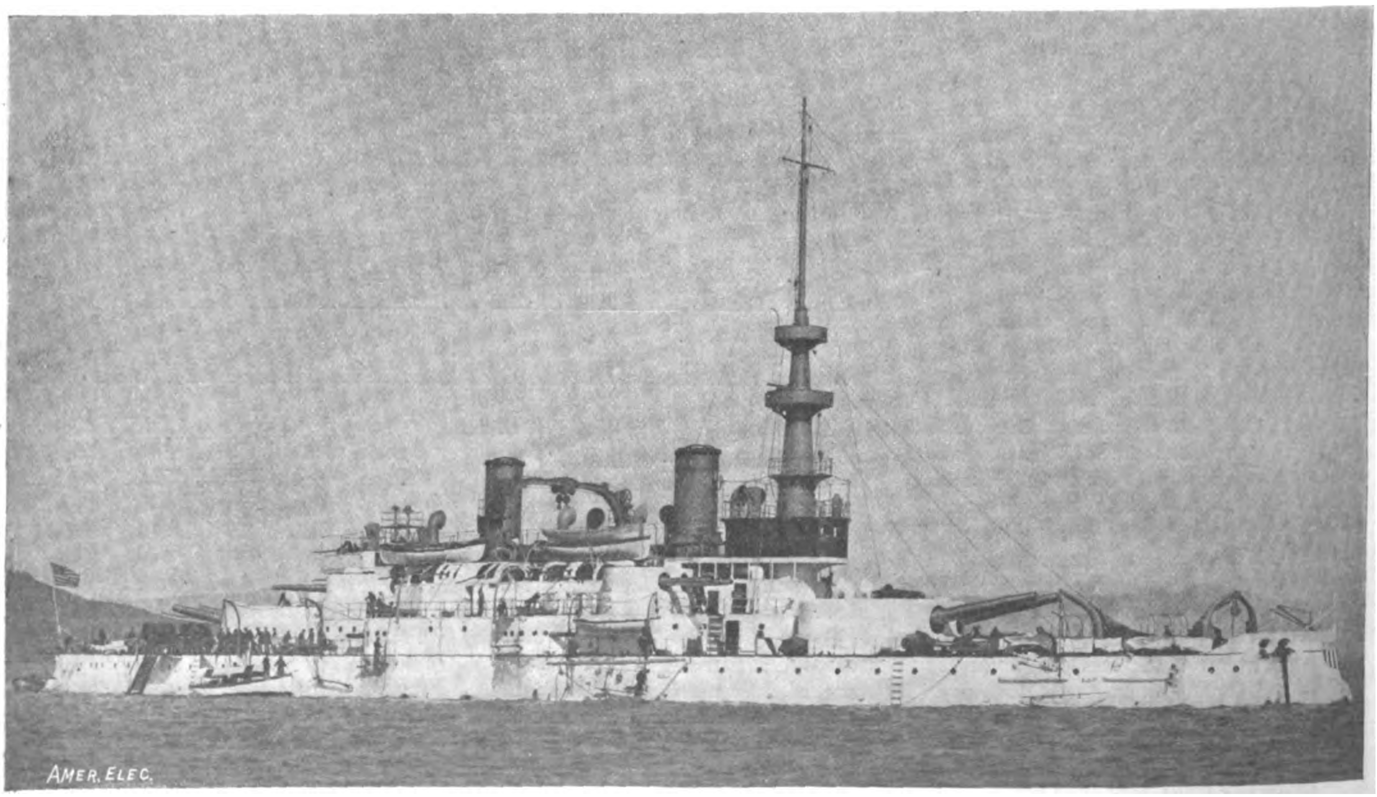

FIG. 1.—THE U. S. BATTLESHIP "OREGON."

ring, on which are engraved all the sixty-two possible combinations of the lamps. Below this plate are ten flat annular discs of brass, insulated from each other, and each connected with one of the lamps. On these discs, below each of the divisions of the index plate, are projections corresponding to the combination of lanterns which is marked on that division under which they appear. Inside the index plate there is a brass cover plate, which revolves on a central spindle and carries with it, near its outer edge, a contact post. This post has a spring projecting point for each of the brass discs. The apparatus is operated in this way:

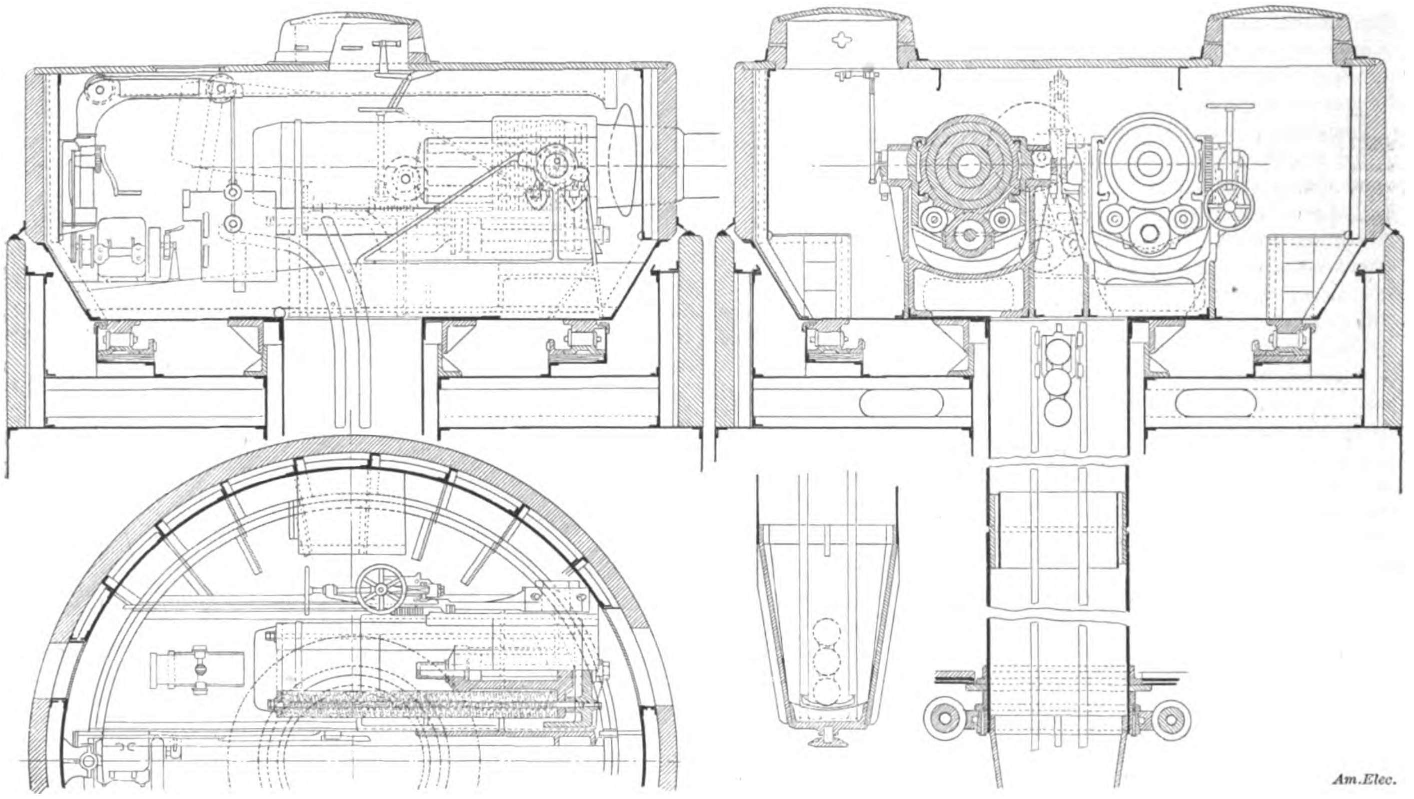

FIG. 3.—SECTIONAL VIEW OF THE TURRETS.

The handle on the brass cover plate is turned until the index points to the desired combination. Then, the plates being clamped, the manipulating spindle is turned through 90 degs., thus bringing the projecting points into contact, and lighting the lamps.

Four of the combinations are used as keys for sets of signals. A code of signals has been formed, comprising as many chapters as there are combinations, or fifty-eight chapters of fifty-eight signals each. The four key signals indicate the change in title of these chapters. Thus we have under each key signal 3364 distinct signals, or a total of 13,456 signals. This system of signalling is unsurpassed for squadron purposes, or for short distance day and night work.

But let us return to the description of installation on the "Oregon."

Next come the fan motors. The two stationary fan motors are used to drive the ventilating fans for the dynamo room. The two sets are exactly similar, consisting of a 2-h.p. electric motor, direct-connected to a Sturtevant blower fan. The fan delivers 2200 cu. ft. of air per minute at a speed of 1570 revolutions. One set forces air into the dynamo room, the other forces the air out.

The portable fan sets are used to ventilate small compartments, such as those in the double bottoms, while the men are examining or cleaning such compartments. Each consists of a blower fan direct-connected to a ¼-h.p. motor, the fan being fitted with 50 ft. of hose. The fan delivers 400 cu. ft. of air per minute, at 1863 revolutions. The fan and motor are rigidly connected, and are very easily moved about.

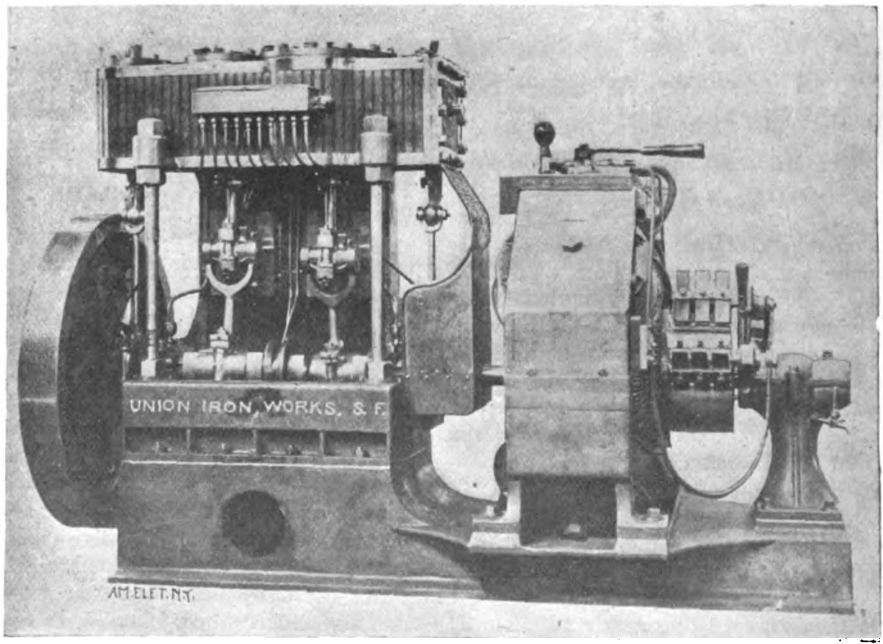

FIG. 4.—ONE OF THE GENERATOR SETS.

The searchlights, four in number, are located two on the chart house forward, and two on the hammock berthing above the superstructure aft. They consist of 60 centimetre Mangin projectors and French lamps. The lamps consume 80 amperes. They are of combined automatic or hand control, and may be electrically controlled from various stations on the ship.

The 8-in. ammunition hoist motors were supplied by the Government. As shown in the drawings of turrets, they consist of an inclosed electric motor, geared to a drum. This drum hoists, by means of a cable, a cage which contains three compartments, one for the projectile and two for the charges. A small swinging crane, shown in the drawing, swings the charge to either rifle. There is a hand hoist attachment in case of break-down. Placing the motor on the turret itself gives the control over the hoist into the hands of the gun crew—a very efficient and convenient arrangement.

The switchboard is arranged with the necessary apparatus and connections for controlling nine incandescent, four searchlight and three power circuits. The pressure board has points for each dynamo and for the searchlight circuits. There is a ground detector which can be thrown on either arc or incandescent circuits, when operated separately.

The system of wiring used is the two-wire system. All the incandescent circuits on the same deck have their ends interconnected through double pole switches, so that if through any cause a circuit or its main is broken, throwing in a few switches restores the light—a very important feature, especially in battle mains. All of the mains for lighting outside the citadel are run as nearly as possible the full length of their deck amidships. They are all fed into their centers by feeders direct from the switchboard. The battle mains inside the citadel are run in the wing passages just inside the armor belt. They light the coal bunkers, magazines, ammunition passages and handling rooms. Those on either side of the same deck are connected by thwartship mains at their centers, and are fed by a single feeder from the switchboard.

The arc light or searchlight circuits are four in number, one for each searchlight. They lead directly from the main switch, and are controlled there by minor switches and cut outs. They have no connections with each other, or with the lighting circuits, except those provided for at the switchboard. All the wiring has a cross section of not less than 1000 cir. mils per ampere at full load, on a basis of .05 amperes per candle power.

It will be noticed in the foregoing description that there are three separate systems on this ship; the incandescent lighting, the searchlight and the power systems. When this plant was installed, the question of electric transmission of power on shipboard was just beginning to be agitated. Consequently little of the current generated on the "Oregon" was used for power purposes. Electrical engineers, however, took hold of the problem with characteristic energy, and to-day the wonderful superiority of electric transmission and electric machinery in the auxiliary mechanism of battleships is fully recognized. In efficiency it equals, while in flexibility and lightness it exceeds, its two chief competitors, hydraulic and steam power.

Thus in the new battleships of the "Oregon" class, we find a much larger installment of electric power. They have eight 32-k.w., instead of three 24-k.w. units, the additional power being nearly all taken by the various motors. Nearly all the ventilation is accomplished by electric power. Motors drive all the ammunition hoists, and are used to train the turrets.

As we more nearly approach the point where the whole auxiliary power of a vessel is electrical, we more clearly see the advantages of that system. We may, therefore, hope that the day is not far distant when electrical marine machinery will less grudgingly receive from the naval powers that recognition of its merits which is certainly deserved.

Types of American Lightning Arresters.

BY HENRY E. RAYMOND.

For use on arc circuits supplied from their machinery, the Western Electric Company manufacture a unique form of arrester. It is designed for use on arc work only and is for use only on their dynamos, being, as it is, incorporated in the assembly of the generators. It forms part of the terminal boards, and is on the same base with the main cutout switch. Apparently it is the intention of the manufacturers to produce a device which cannot be overlooked, and in which simplicity of action and construction are distinctive features. One of the most unique features is the method of rupturing the ensuing arc. The magnetic lines of the main field coils are used to accomplish this. This is not clearly shown in available illustrations, but probably the stray field lines of force are used to accomplish this useful work.

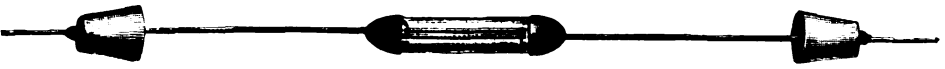

FIG. 1.—FUSE OF AJAX ARRESTER.

The arrester consists simply of a carbon plate and two carbon or metal pencils. The carbon plate is set on the base edgewise and stands in a vertical position, its plane crossing that of the base as a perpendicular line. To this plate ground connection is made. On either side of this plate is one of the pencils. These are connected one to each terminal of the generator, and are so arranged that their position in relation to the carbon plate is adjustable. The complete device is placed upon the dynamo in such a position that the field magnetism will force out and rupture any arc which might set up after a static discharge had taken place.

FIG. 2.—FIBRONE CHUTES OF THE AJAX ARRESTER.

The manufacturer of the Ajax arrester has produced a device which is a class by itself. The action depends upon an exceedingly small gap and a fuse which forms a part of this gap. The destructible nature of the discharge points is the distinctive feature of this arrester, and the makers hold that such a condition is necessary to effective work. In so far as protecting the dischargers from the effects of a rush of dynamo current succeeding a discharge there not only is no provision made, but there is a certain arrangement of contact which makes their destruction practically certain. The construction of the arrester places in the path of a static discharge a resistance almost negligable and offers no inductive opposition either in shunt or series with the gap. The instrument consists primarily of fuses, almost direct to the ground, and an automatic arrangement for bringing successive fuses into contact with the line. These fuses are not continuous from line to ground, but are in two pieces, separated in the middle. The two ends meeting at the middle are then overlapped and sealed in position with small wax pellets. They are made of No. 26 brass wire, wrapped with silk. This covering is not removed and serves as the dielectric which fills the gap. This fuse, Fig. 1, has a small glass tube inclosing the overlapping portion, which is about 1 in. long, which serves to keep out dirt and moisture. The silk wrapping holds the ends about .002 in. apart when the arrester is to be used on pressures not over 125 volts. For voltages greater than this the gap must be increased proportionally. The extremities of the fuse are passed through soft rubber plugs, which hold the fuse in place in the Fibrone chutes, Fig. 2, provided for that purpose.

In Fig. 3 we have a view of the general assembly of the arrester. This cut represents the station type, and is a cross sectional view of a switchboard on which it is mounted, showing the choke coil mounted on the back. The back of the arrester is of porcelain, with grooves for the line and ground terminals. On either side of these two grooves and in respective con-

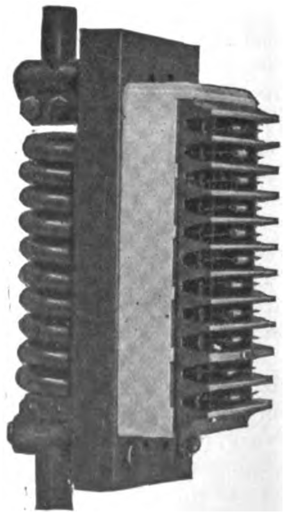

FIG. 3.—GENERAL ASSEMBLY, AJAX ARRESTER.

nection with each, are two other grooves containing contact springs which press against the fuse terminal connections when the cover which holds them is put in place. One end of each fuse, of which there are eleven, is attached to a common connection which is in contact with the ground terminal spring. The opposite ends project into a semi-cylindrical chute in the back of the cover, the back of which is metal in contact with the line terminal spring, but not touching the fuse ends. This metal trough, which is vertical, contains a carbon ball which is free to move up or down. Normally this rests on the highest fuse end, and brings it into connection with the line. Any discharge is followed presumably by the current, and the fuse in contact with the ball is instantly vaporized. As each fuse is destroyed the ball drops to the next below, bringing them successively into contact with the line terminal. The very small gap in this arrester permits the use of an idea which in almost any other form would be strictly unallowable. This idea is to have the contact between the fuses and carbon ball so imperfect that even were the gap portion of the fust not destroyed the end part would instantly be vaporized.

The inventor bases his claims of superiority on the principles that a very short gap is necessary, that fuses are cheaper than armatures, and that the necessary attention required by the insertion of new fuses is a distinctive gain.

The Universal Non-Arcing Lightning Arrester is another rather distinctive type. The dealers state that it was originally designed to meet the requirements of long distance transmissions in mountainous districts, and that it was so successful that its use was extended into other fields. It is now adapted for use on incandescent, arc and power circuits, for alternating or direct-current, long or short transmissions and is applicable to any location. The dealers' description will probably give a clear idea as to its action. They say:

"Embodying the old and well tried principle of air gaps enters into the first essential requisite of this instrument. Placed in a block form between two serrated metallic conductors are several alternate layers of non-arcing metal and mica. All the parts are thoroughly insulated from each other, supported on a porcelain base and protected by a spun brass cover, and can be attached to a pole or switchboard by means of an iron bracket." It will be seen in Fig. 4 that the two serrated plates are fastened at the top and bottom of the arrester case, and that the gap to the non-arcing layers is quite small, probably to make up for the extra dielectric strength interposed by the layers of mica.

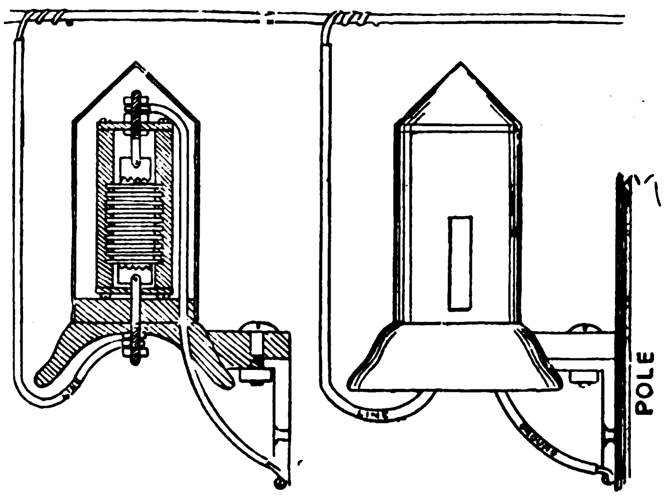

FIG. 4.—UNIVERSAL NON-ARCING ARRESTER.

These mica sections are as thin as possible and certainly offer great opposition to the passage of dynamo currents. It is intended that the discharge, after passing the first gap shall be disrupted into a number of minute sparks so small that only an infinitesimal amount of current can follow. It is claimed that the discharge is so broken up by the time it reaches the second gap that it is utterly unable to start any arc composed of dynamic current. The arrester is free from movable contacts, magnets and fuses, and it is claimed to be independent of attention. It possesses apparently a fairly high striking voltage. It is manufactured for all purposes in practically the same way, the greatest difference lying in the quantities of alloys used in the metallic plates.

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ELECTRICAL TURRET TURNING GEAR.

Lieut. Wm. R. Rush, who had charge of one of the turrets of the U. S. S. "Brooklyn" during the late war, in a recent report indorses fully a report of a Board in favor of electrical turning gear, as follows:

"The Board begs to reiterate its unqualified approval of electricity as the power for training turrets. To anyone who has trained turret guns upon a target by electricity, and who has afterward attempted to do it by any other means, the contrast is too striking ever to be forgotten. The electric motor and controller give perfect control and fineness of train to an ideal degree."

Lieut. Rush adds that after experience in handling turrets under fire in a running fight of four hours he found the temperature of the closed handling room of the steam turrets was terrible in comparison with that of the electric turrets. There was also the danger of death to everybody in the handling room from shell cutting a steam lead.

THE PREVENTION OF SPARKING. AND THE SELECTIO OF TYPES OF ARMATURE CORES AND WINDINGS.

BY PROF. A L. RICE.

In order to understand the use of methods to prevent sparking, it is necessary to understand the causes which produce sparking. A spark is always formed when a current is broken, and the larger the current, the larger will be the spark. The main current of a dynamo or motor is not broken as the brush passes from one bar to the next, for an ammeter in circuit shows no such effect; hence the spark must be due to the breaking of some other current.

A brush is always wide enough so that, as it passes from bar to bar, it will bridge the insulation for a short time. This will give a chance for a local current to flow around the coil thus short-circuited (see Fig. 1), and through the brush; as the resistance is small, even a small e.m.f. will produce quite a large current. As a coil moves to the position where the bars to which it is connected are joined by the brush, it is near the point of no action; i. e., where no e.m.f. is generated in its conductors by revolution in the magnetic field. There would be no current established if it were not for the self-induction. This tends to prolong the current as it dies away; as the leading end of the coil reaches the brush the whole current due to one circuit is flowing through it, forced by the other coils in the circuit. (See coil 1, Fig. 1.)*

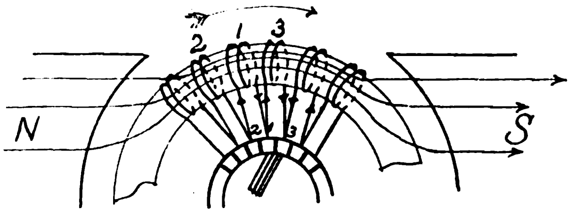

FIG. 1.—ILLUSTRATING COMMUTATION.

As the brush short-circuits coil 1, the current gradually changes from bar 1 to bar 2, and coil 1 tends to go out of action. But the self-induction prolongs the flow of current so that there is a considerable amount flowing, as indicated in Fig. 2, when it becomes time for the brush to break with bar 1 and for coil 1 to receive current from coil 3 in the opposite direction. Unless it is previously done by external means this current must be stopped and the current from coil 3 set up at the instant that bar 1 leaves the brush; thus a spark will be produced and heat generated, which heat will melt a small bit of the edge

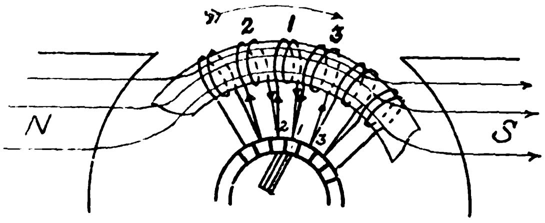

FIG. 2.—ILLUSTRATING COMMUTATION.

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*The figures and discussion have been made from a Gramme ring armature, but the same principles apply to either drum or ring construction.

of the bar and thus produce cutting. Evidently, in order to stop sparking, the current in coil 1 must be stopped and reversed before bar 1 leaves the brush. The larger the current being drawn from the armature, the larger will be the current flowing in the coil during the time of short circuit, and the greater will have to be the means employed to prevent sparking. If the field be displaced so that the short circuiting occurs while e.m.f. is still being generated in the coil, the current will be larger and the sparking more violent.

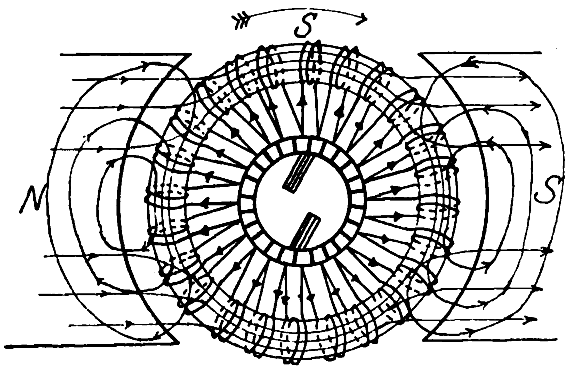


FIG. 3.—DISTORTION OF MAGNETIC FIELD.

It is a well known fact that current flowing in the armature tends to magnetize the core at right angles to the magnetization produced by the field poles. (See Fig. 3.) This tends to twist the field around in the direction of rotation, thus making the leading pole tips strong and the trailing tips weak, because in the following tips the lines created by the armature oppose those set up by the field winding, and in the leading tips assist them.

If the brushes are set half way between the pole tips, the short circuiting will occur while a coil is still in the edge of the field, due to the strong pole tip. The larger the current drawn from the armature, the greater will be the cross magnetization of the armature core, the more will the field be twisted around, and the greater will be the sparking if the brushes are kept half way between the pole tips. The brushes may be set forward in the direction of rotation as much as the magnetization is shifted, and it will take care of the effect of the cross magnetization due to armature current, if the amount of shifting is varied as the armature current varies.

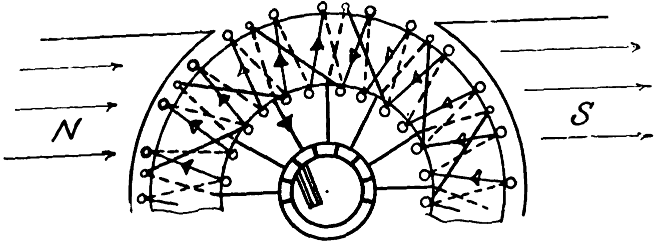


FIG. 4.—SAYERS WINDING.

This will not prevent the sparking due to self induction, but that may be overcome by shifting the brushes still further ahead, until the e.m.f. due to the rotation in the field of the following pole tip is sufficient to neutralize the e.m.f. of self-induction before bar 1 leaves the brush. This amount of shifting will also have to be varied as the amount of armature current varies.

Good design will do much to reduce the amount of sparking. The larger the number of turns in a coil the greater will be the induction, so that it is best to use few turns per coil, but this for high voltage means many coils and commutator bars, which will make the construction expensive. The usual practice allows about 5 volts between adjacent bars for a 125-volt machine and about 15 volts for 500 volt generators.

To reduce the distortion of the magnetization the forward pole tips may be so shaped as to be nearly saturated at no load, and, for a toothed core, the saturation of the teeth will work toward the same end. This saturation will tend to make a "stiff field," i. e., one not easily distorted, and thus reduce the twisting effect of cross magnetization. Special forms of winding have been devised to reduce the sparking, among the most prominent being the Sayers and the Ryan.

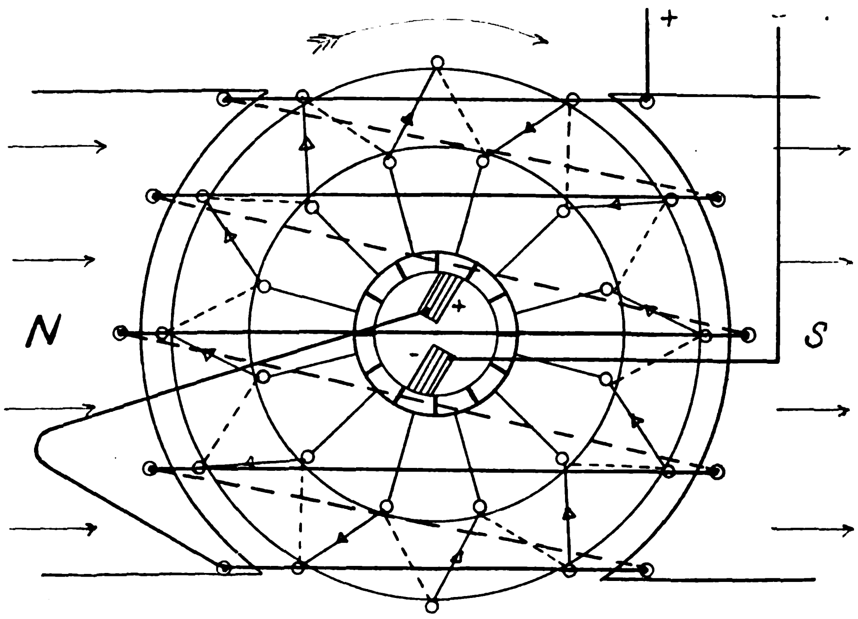


FIG. 5.—RYAN WINDING.

In the Sayers winding the coils are connected together without taking leads to the commutator (See Fig. 4.) The connection is then made to a commutator bar from the junction of two coils, through a "commutating coil," which coil is wound on the armature core in opposition to the main coil, but placed behind the main coil against the direction of rotation far enough so that, as the main coil is being commutated in the position of no field, the commutating coil on account of its position will generate a back e.m.f. sufficient to overcome the e.m.f. of induction in the main coil, and also the effect of the cross magnetization. (See Fig. 4.) Since the coils are in opposition, they will neutralize each other's cross magnetization and induction; and the current will increase in both at the same time, so that induction effect will be neutralized independent of the load. The commutating coils are only in circuit at the time of commutation; at other times the current flows through the leads from coil to coil without passing through the commutating coils. This device introduces some complication, but is, perhaps, as successful as anything yet devised, though not extensively in use in this country.

The Ryan winding consists in putting a compounding or series coil wound in slots or tunnels in the pole-pieces on the dynamo, so that the effect of armature cross magnetization will be just neutralized at each point. (See Fig. 5.) In this way, the distortion of the field is prevented and, if the lead be made sufficient to neutralize the e.m.f. of self-induction all sparking will be avoided, no matter what the load.

In deciding on the style of winding for any machine, the points to be considered are convenience in winding and in repairing winding, size of wire to be used, cost of making punchings, probable sparking, mechanical strength and amount of magnetization required. Between the wire-formed coil, the bar and the cable windings, it is a matter of size of wire to be used and number of wires to be connected.

The wire wound armature is often used for small sizes where the wire is too fine to wind well into a formed coil and would not hold its shape well when wound; it is also often used for Gramme ring armatures with toothed cores where it would be impossible to put on formed coils. For small drum armatures, this winding is difficult to repair on account of the crossing of the coils at the ends, and it is inconvenient to wind and to insulate for high potentials; to get mechanical strength the winding must be well bound into place. The Gramme ring winding is expensive to apply, but is more readily repaired, as there is no crossing of coils; since the coils surround the core there is necessity for only enough binding to prevent sliding of the wires around the core if it be smooth.

The smooth core is almost entirely abandoned at the present time. It necessitates rigid binding to keep the wires in place, and a long air gap in order to get room between the core and the poles for the armature conductors. The method of holding conductors by binding is not good mechanically, and the long air gap necessitates a large amount of copper in the field winding; the only advantage of the smooth core is that the long air gap gives a field not readily distorted by the cross magnetization of the armature.

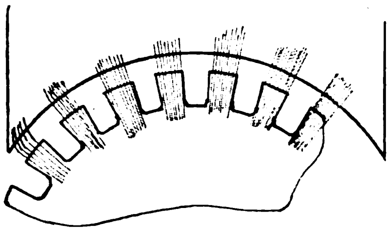


FIG. 6.—DISTRIBUTION OF FLUX IN TOOTHED CORE.

The toothed core provides a firm mechanical support for the conductors, protects them from injury and makes it possible to cut down the distance between core and poles to that which is needed for mechanical safety. The difficulty with this form of core comes from the fact that, if the spaces between the tops of the teeth are made large the flux becomes tufted (Fig. 6), thus setting up eddy currents in the pole faces as the tufts sweep across them. This causes heating of the poles. Also, the small gap makes a field easily distorted by the armature cross magnetization, thus making a machine more likely to spark with change of load. The tufting can be avoided by using overhanging teeth, Fig. 7, but this makes a slot into which it is more difficult to get the coil than if the straight sided tooth be used.

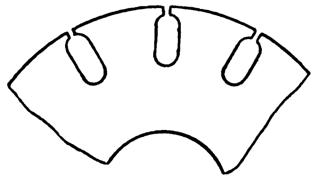


FIG. 7.—OVERHANGING TEETH.

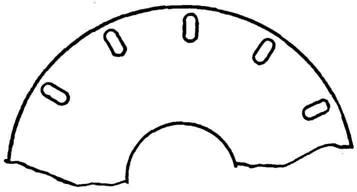


FIG. 8.—TUNNELED CORE.

The heating of the poles may be avoided by using laminated pole-pieces or narrow slots cut in the pole face parallel to the laminations of the armature core.

The field distortion can be remedied by using teeth of such small cross section that they will be nearly saturated at normal load, thus giving a high magnetic resistance to take the place of that removed by shortening the air gap, and making a quite "stiff" field.

The formed coil winding is the one most in use at the present time for dynamos of moderate output. It is easily made and applied, and a coil can be easily replaced; a toothed core with rather wide openings between the tooth tops must be used, but the openings should never be more than 2½ times the length of the air gap if tufting is to be avoided.

For large size machines, the wire becomes too stiff to be easily made into formed coils. Resort must then be had to bar or to cable windings. The bar winding is used in many cases where coils might be used, because rectangular bars are more economical of space than round wires. The insulation and connecting of the bars is more expensive than the winding of formed coils, but not much more so than the winding and connecting of cables or heavy wire. Either bar or cable windings are generally put into tunnels made by punching holes in the armature discs, Fig. 8. The joining of the tooth tops tends to increase somewhat the leakage of magnetic lines from one pole to another, but it makes a disc which is somewhat easier to punch than is the disc with separated teeth.

If the spaces between tooth tops have been made too large, so that heating and sparking are present, it may sometimes be remedied by winding on the surface of the core a layer of iron wire, thus making practically a tunnel for the conductors. For the toothed or tunneled core, the slots generally have parallel sides in order to make convenient winding, though the use of a wedge shaped slot, larger at the inside end, holds the wire more firmly in place.

The toothed and tunneled cores carry the flux entirely in the teeth and thus avoid eddy currents in the conductors themselves, but the self-induction of the coils is increased by the iron inside them. The bedding of the conductors in the core makes insulation for high voltages more difficult and necessitates a larger space for insulation.

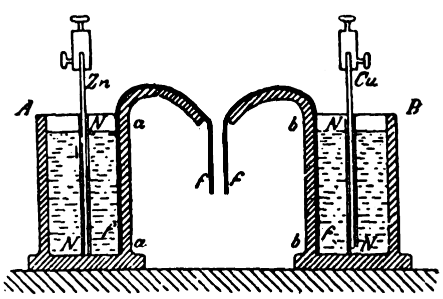
The appropriate use of various forms of winding has been discussed under each form in previous articles, so need not be mentioned here. In general, lap windings are used for bipolar machines, wave for multipolar. The multiple windings are used for medium voltages and medium currents; the series windings for high voltage; and the telescope windings for low voltages and large currents.

Among our Foreign Contemporaries.

Edited by CHARLES T. CHILD.

Experiments on the Use of Blast Furnace Gases for Engine Driving.—M. Aimé Witz writes in "La Revue Technique" a very complete description of experiments recently made upon the utility of blast furnace gases for the operation of large gas engines. The engine used was of a single cylinder type, about 32 ins. diameter by 40 ins. stroke, running at 105 r.p.m. with a compression of 110 lbs. and 200 nominal h.p. The gases were taken directly from four furnaces or could be passed first through a gas holder of about 55 cu. ft. capacity. A friction brake was used to absorb the power of the engine, arrangement being made for supplying it constantly with cooling water so that it could be used during a 24-hour run. The water used for cooling the cylinder and for washing the gas in scrubbers was very carefully measured. The consumption of gases averaged 117.5 cu. ft. per effective h.p. hour, the consumption of water being 220 lbs. and of oil and grease less than ½ oz. These averages were made during tests extending over a period of twenty-four hours.

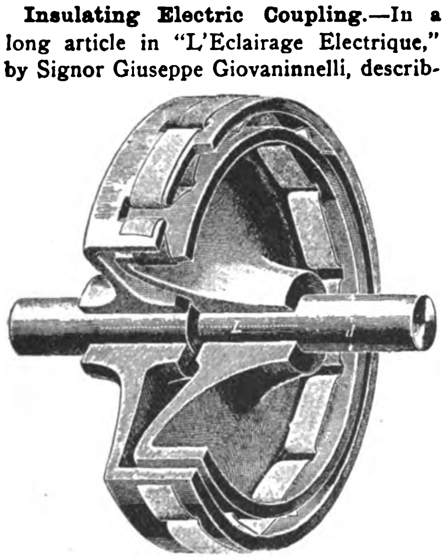
Copper Sulphate Standard Cell.—In "Elecktrotechnische Zeitschrift" Herr Grotian describes a modified form of the Daniell cell, which is very easily constructed, and useful as a standard cell. It is not so constant as the Clark or Weston cell, but sufficiently so for most purposes. The figure herewith, taken from an abstract in the (London) "Electrical Review," shows the arrangement adopted by the author: Two cells are provided, of porcelain, hard rubber or other suitable material, each having a long lip on one side. One of these cells contains the zinc and its solution, while the other contains the copper and its solution. The plates are held in the cells in a fixed vertical position by any simple means. A piece of blotter or filter paper is hung down over the end of the lip of each cell, as shown in the illustration, each being saturated with its own solution, and the two are allowed to come into contact at the bottom. The liquid flows over by capillary attraction and drops fall off the ends of the paper. The copper plate should be given a coat of pure electrolytic copper, and the zinc plate should be of pure metal, well amalgamated. The zinc solution should have a specific gravity of 1.2 and the copper



COPPER SULPHATE STANDARD CELL.

solution of 1.1. The e.m.f., as determined by the Reichsanstalt, is 1.101 volts. The resistance is several thousand ohms and the cell will stand short circuit without injury. When the cell is not in use its e.m.f. rises at the rate of two or three thousandths of a volt per day.

Insulating Electric Coupling.—In a long article in "L'Eclairage Electrique," by Signor Giuseppe Giovaninnelli, describing the installation at the Falls of Kerka in Dalmatia, a most simple and ingenious flexible coupling is illustrated. The illustration, which is reproduced herewith, requires little explanation. Two castings, as shown, are mounted on the extremities of the shafts, which are brought close together, but not in contact. A number of windows are cut in the flanged circumference of each and through these an endless cotton belt is passed, in the way shown in the illustration. The great advantages of this simple coupling are that it will work quite well when the shafts are not exactly in line with each other, that it possesses considerable elasticity and that it forms an effective insulation where this is desirable, as in the case of a dynamo direct-driven from an engine or turbine.



INSULATING FLEXIBLE COUPLING.

Electrical Canal Haulage.—Mr. A. H. Allen read before the recent meeting of the British Association an interesting paper having the above title, which is printed in full in the "Mechanical Engineer." The system about to be tested on one of the large British canals is fully described. On the tow path is built, at a height of 9 or 10 ft., a rigid structure composing two Z-bars braced together at one side and supported at intervals of about 30 ft. on cast-iron or wooden posts. Each of the Z-bar rails constitutes a track for a number of locomotives. These consist simply of a motor mounted on a four-wheel carriage so that two of the wheels run on the upper side of the rail and the other two on the lower. Fig. 1 shows an end view of two locomotives passing, and Fig. 2 shows a side elevation of one of the motors. As may be seen from the latter, the motor shaft carries a worm at each end gearing with a worm wheel on each of the four axles, so that all of the wheels are drivers. It is stated that the tractive force required to tow a barge carrying 100 tons of freight on an ordinary canal at the rate of 2½ miles per hour, is from 250 to 300 lbs. or about 2 h.p. In order to get up speed in a short time the motors are made capable of giving a pull of about 600 lbs., the weight of the motor and carriage being less than 1000 lbs.

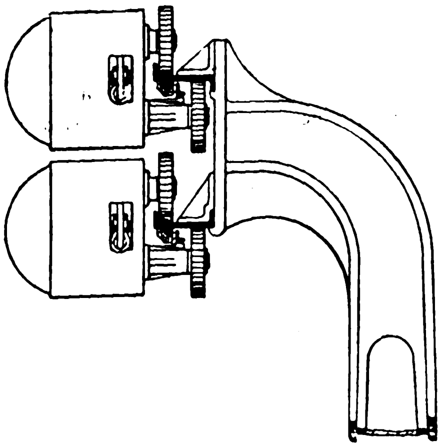


FIG. 1.—ELECTRIC CANAL MOTOR, END VIEW.

To the left side of each rail is bolted a continuous creosoted wooden batten which supports the strap copper conductors. These are insulated from the wood with porcelain insulators. The position of the conductors, which is clearly shown in Fig. 1, is such as to shield them from the weather and from mechanical injury. In passing, the boat being towed by the motor on the lower track steers close to the towing path, while the other steers wide, the ropes thus passing clear without any danger of entanglement. A light cord runs from the boat to the motor controller and a simple switch is arranged so that alternating pulls on the controlling cord open and close the circuit. It is stated that on a level canal 30 miles in length, with an annual traffic of 100,000 tons per mile, the cost per ton mile and the time occupied in transit will be as follows:

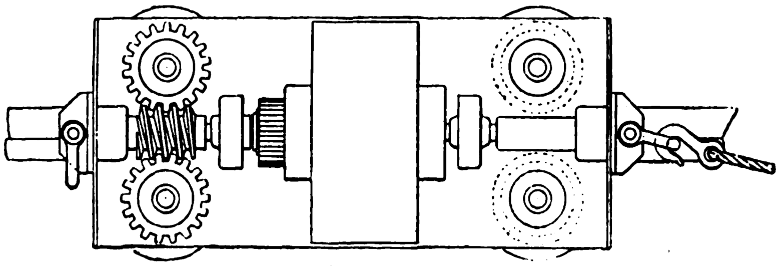


FIG. 2.—ELECTRIC CANAL MOTOR, SIDE VIEW.

	Cost.	Time.
Haulage by horses at 2½ miles per hour...........	.039 cents.	15 hours
Electric haulage at 2½ miles per hour..........	.016 cents.	12 hours
Electric haulage at 4 miles per hour..........	.020 cents.	7½ hours

The Action of Electricity on Plants.—An interesting paper was read by E. H. Cook before the recent meeting of the British Association, and is abstracted in "The Electrician." It appears that experiments upon the influence of electricity on plants were made as long ago as 1806, but the results were generally negative or uncertain.

The author's experiments extended over a period of twelve years, and were described under three heads: Those relating to the germination of seeds, to the growing of plants in soil, and to the lower forms of plant life, such as algæ, fungi, etc. In the case of seeds, barley, wheat, peas, etc., through which a current of 1 to 10 milliamperes was passed while they were germinating, an increased development of from 10 to 20 per cent was noticed over seeds not electrically treated. Electrification with a Wimshurst machine seemed to result in the germination of a larger proportion of seeds thus treated. Upon growing plants the electric current seems to exert no appreciable influence. Electrification, however, from a high tension machine showed a marked increase in the rate of growth. The curious fact that hyacinths grown from the same bulbs and negatively electrified, produced different colored flowers from those positively electrified, was also noticed. The results with experiments with the lower plants seemed to be indefinite. A quotation was made from the work of some French experimenters along the same lines, and most remarkable results are alleged to have been obtained by the use of a sort of lightning conductor set up in the middle of a field and connected to a system of wires running under the soil near the roots of the plants. An increase of 50 per cent in the weight of potatoes grown in patches of the same size, or an increase in the money value of the crop amounting to about $45.00 per acre, is said to have been thus obtained. The author did not attempt to account for the phenomena observed.

A Primary Battery Without Acids.—"L'Industrie Electrique" contains a description of an interesting new type of primary battery. This cell is really a variety of accumulator which recharges itself through atmospheric oxidation. The principle is as follows: A fresh surface of lead becomes covered in a short time, when exposed to the air, by a skin of oxide. Such a plate treated with sulphuric acid has this oxide changed to a mixture partly of lead and partly of lead sulphate. This mixture of the sulphate and the metal is a solid coating adhering to the mass of the lead plate and is, on account of this peculiar condition, quite different from the ordinary white sulphate of lead. A plate thus treated and a zinc plate, in a solution of sulphate of zinc, form the battery. It remains entirely inert on open circuit, but on the establishment of a current, the sulphate of lead is reduced to a metallic state and the zinc dissolved, with the formation of sulphate. When all the lead sulphate has been reduced by discharge, all that is requisite is to expose the lead plate to the air until it has oxidized on the surface, and then treat it again with sulphuric acid.

This article goes into an elaborate description of the details of construction of a battery of this character, arranged for the withdrawal of the liquids, and the airing of the plates, etc., in place. The constants of a cell of this type are given as follows: Weight of the lead plate, 15.5 lbs.; e.m.f. 0.54 volts, initial current, 6 amperes. Total discharge, 187 ampere hours. The price of current generated by this means is said to be in the neighborhood of 53 cents per k.w. hour.

The Water Power Station at Sihl, Switzerland.—A station possessing many points of interest has recently been built at the village of Sihl, in Switzerland, to serve the region along the west side of Lake Zurich, a neighborhood well filled with small industries. The hydraulic works required for the development of the water power are on a scale of considerable magnitude and are well shown in the map, Fig. 1, herewith, taken from "Le Génie Civil." From a dam on the river Sihl a tunnel about 3 miles long conveys the waters of the river to a pond formed by damming a narrow valley, the tunnel being able to deliver a maximum of 750 gals. per second. The construction of the tunnel was one of great difficulty, as the soil through which it was driven was full of blocks of stone and boulders separated by earth, thus requiring a masonry revetment throughout its whole length. The pond into which this aqueduct delivers the water contains about 52,000,000 gals. From it to the power plant extends a metallic conduit about 5 ft. 6 ins. in diameter, built of steel about ¼ in. thick and fortified externally with a heavy layer of concrete. It is supported at numerous points by heavy cast-iron collars resting on concrete foundations The lower section of this tube is ½ in. thick. On account of the great length of the conduit (nearly half a mile) unusual provisions were necessary for the avoidance of the shock due to the sudden stoppage of the stream of water. At a point near the bottom of the conduit was constructed a chimney or vertical standpipe. 7 ft. 6 ins. in diameter and 67 ft. high, built of 3-16 in. steel and permanently connected with the conduit (Fig. 2). The lower part of this standpipe, which is under ground, is surrounded with a heavy shield conduit.

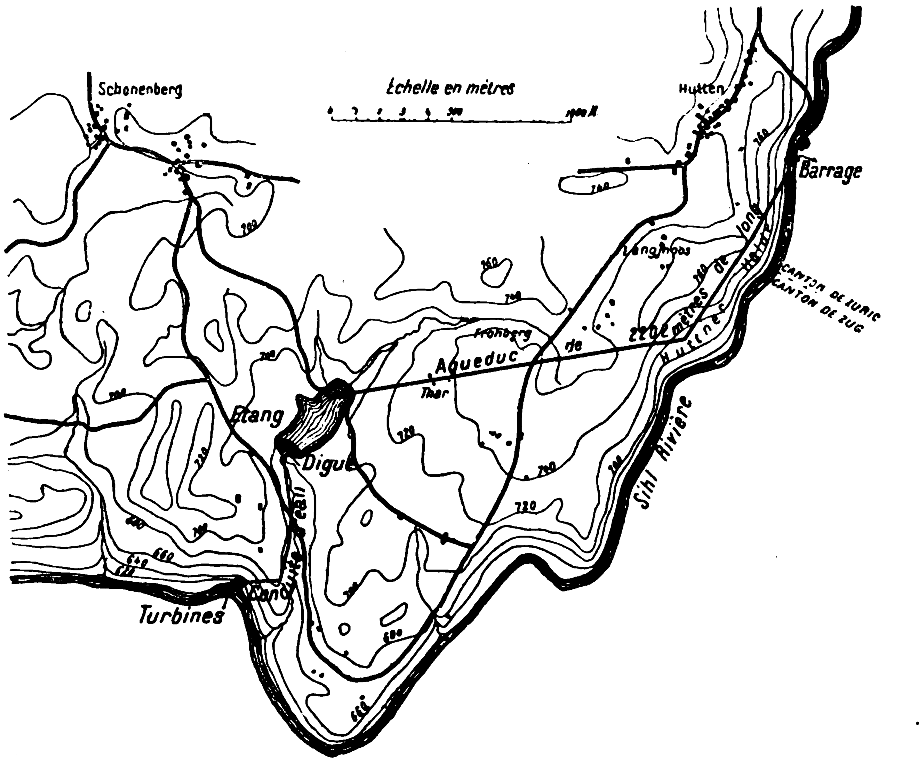


FIG. 1.—MAP OF THE SIHL INSTALLATION.

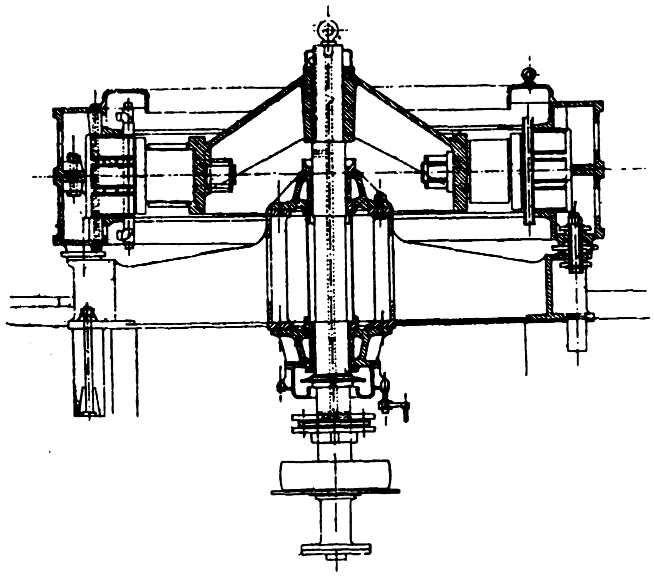


FIG. 3.—VERTICAL CROSS-SECTION OF DYNAMO.

Vertical shaft turbines are used, carrying the revolving field of the dynamo on their upper extremities. The installation comprises five machines, each of 400 h.p., running normally at 360 r.p.m. The dynamos, of which Fig. 3 shows a cross-section, are the well-known Brown-Boveri type, generating directly a pressure of 5000 volts at forty-two cycles per second. These dynamos are arranged so that the whole output may be taken off at a two-phase current or as a single-phase current. There is nothing specially noteworthy about the transmission lines and sub-stations, which are of the usual excellent Swiss type. Only induction motors are used on the system, and the power motor is said to be 80 per cent.

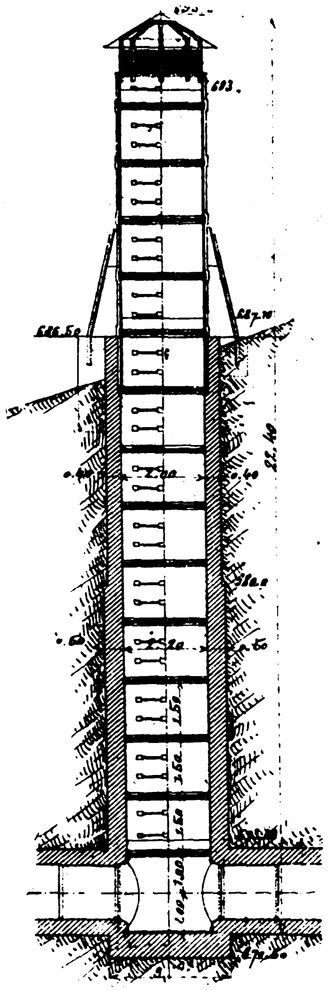


FIG. 2.—STAND-PIPE ON TURBINE PENSTOCK.

A New Type of Storage Cell.—The "Electrician" describes an interesting new type of accumulator designed by Mr. Marquand. Lead is cast in solid ribbed plates, which are then packed in sets of two or three, imbedded in powdered sulphur in moulds. The boxes of lead plates and sulphur are then arranged in racks so that the hot gases from a furnace pass around them and allow them to slowly heat up to the melting point of lead, at which temperature they are kept for about an hour. A skin of sulphide forms on the surface of the plates and prevents any deformation or running of the lead, as if it were encased in a tight envelope. This sulphiding process being complete, all of the plates are converted into negatives in a forming bath, positives being afterward made from these by reversing their polarity in a similar bath. It is said that plates of this type can be turned out complete ready for service in twenty-four hours.

Memorial to Maxwell.—The (London) "Electrical Engineer" announces that a suitable memorial is to be erected to the memory of the late James Clerk Maxwell in Corsock Parish Church. The eminent Professor Maxwell was closely connected with this church throughout his life, and it is considered a most appropriate place for a memorial to his memory. Subscriptions fixed at one-half guinea should be sent to Rev. George Sturrock at Corsock, by Dalbeattie, N. B.

Electro-Thermic Mining Cartridges.—"La Nature" gives a short account of an original proposition made by Major M. H. Shaw at a recent meeting of the Institute of Mining Engineers for the use of cylinders of water brought to a high temperature by means of an electric current in place of dynamite or such other explosives in dangerous coal mines. Of course this explosive is very much less powerful than dynamite, but it is considered to be sufficiently strong for coal mine work and is, of course, perfectly safe, not only on account of no fire being concerned in its explosion, but also because the cartridges can be handled with entire safety by anyone.

The English Corps of Volunteer Electrical Engineers.—Not the least of the many services for which the electrical profession owes a debt of gratitude to the late Dr. John Hopkins, says "Lightning," is the formation of this corps. Last year its officers were chosen and went through a preliminary training at Fort Victoria on the Isle of Wight. During the present year over 100 volunteers have been enrolled from members of the electrical professions. It is said that the officers of the regular army are greatly pleased with the work of these volunteers so far, but it is expected to increase the corps to seven companies in the near future.

Now that the military forces of this country are receiving so great a share of public attention, it seems a fitting time for the formation in the United States of a corps similar to this. In the early days of the late war with Spain a trained corps of electrical engineers skilled in telephone, telegraph and signal work, the laying of cables and mines, the installation of all sorts of electrical apparatus, and drilled to make the best of sudden emergencies, would have been absolutely invaluable. It is to be earnestly hoped that the movement which resulted in the formation of the first volunteer regiment of engineers, who are at this writing in Porto Rico, will be continued until it results in the establishment of a volunteer corps of electricians having a status similar to that of our Naval Militia.

A Plastic Insulating Substance.—"L'Électricien" gives the following formula, due to M. F. A. Magdolf, for a plastic insulating substance which soon hardens. Gum-lac, or a mixture of this gum with other resins, is dissolved in alcohol or any other convenient solvent which will mix readily with water. In this solution are stirred insoluble substances, such as powdered asbestos, powdered glass, silica, metallic oxide, coloring matters or other such things as may be desired, and water is then slowly added while the mixture is stirred. The gum is thrown down in a finely divided precipitate, intimately mixed with the powdered substance. The mass soon hardens and, if desired, may then be pulverized and moulded in a hot mould under pressure.

Monazite Mines.—The "Mechanical World" contains an interesting note on the mines of monazite in Brazil. This material is the principal source from which the rare earth oxides composing Welsbach mantles are obtained. The most extensive deposits are in the district of Bahia and occur in the shape of banks of sandstone on the sea coast. The sands are quite rich in monazite and may be loaded directly on vessels. The same mineral has recently been discovered in the United States of Colombia and Buenos Ayres.

Wireless Telegraphy.—In a somewhat ponderous editorial on Wireless Telegraphy, the "Electrician" discusses the efficiency of space signaling, both in the arts of peace and war, and comes to the conclusion that there are a number of ways in which this variety of signaling can be turned to good account. The possibilities of space telegraphy in communicating between moving trains have not been thoroughly exploited, and it is thought that this may be a profitable direction for future endeavor. For signaling the arrival and departure of vessels at various coast points, for communicating between vessels at sea and as an accessory to lighthouse service, it is perfectly possible that the ether-wave telegraph system may find uses.

It has remained for this country to originate the most recent and remarkable application of this variety of space signaling. A well-known inventor has just proposed to use electric waves for communicating between points on shore and automobile torpedo boats which are to prowl around the coast at night and strike terror into the heart of invaders. The mechanism of this craft is so remarkable that it is proposed to exhibit it in Paris during the forthcoming exposition while the inventor operates it from his office in New York!

Electric Boats for the Russian Government.—"L'Eclairage Electrique" gives some data of the new electric boats ordered from an English company by the Russian Government. These boats are 32 ft. long, 8 ft. beam, draw 40 ins. of water, and can accommodate twenty passengers each. They are built of mahogany with bronze trimmings, and each is operated by forty elements of accumulators in water-tight, hard-rubber boxes. All of the elements are permanently connected together in series, and speed regulation is accomplished by the use of two separate windings on the motor armature, which is provided with two commutators. These windings are put in series or parallel after the well-known fashion used in street railway motors. With 10-h.p. the speed of these vessels in still water is 12 miles per hour, and the outfit can run at full speed for four hours. At an output of 5 h.p. the battery will work for eight hours without recharge and the speed is very little reduced.

Electrolytic Cooking Utensils.—There has been, according to "L'Elettricità," some difficulty encountered in the electro deposition of copper in hollow matrices for the manufacture of pots and other cooking utensils because the finished vessel is only separated with difficulty from the mold. A new process provides the matrix with a valve at a convenient point. When the copper is thick enough water under high pressure is admitted by this valve at a point between the copper and the matrix and strips off the former easily. It is said that these vessels are not only stronger than those beaten by the ancient process, but also much cheaper.

Recording Pyrometers.

To the Editor of American Electrician:

The pyrometer described on p. 422, September number of the "American Electrician," can scarcely be called new. About ten years ago Le Chatelier brought to notice the use of a thermo-couple of platinum and platinum-rhodium alloy (10 per cent rhodium), for the measurement of high temperatures, and about seven years ago Prof. Roberts Austen designed a recording form of apparatus, the records being made on rapid bromide paper by means of a spot of light.

Several of these pyrometers are in use in the Cleveland district for indicating the heat of the blast supplied to the blast furnaces. At our works (blast furnaces) we have used two electric pyrometers (platinum and platinum-rhodium couples) for the last six years, one for the use of the foremen and stove minders, and the other a recording instrument. By using a switch operated every half minute by clockwork, we get the records of two furnaces on one sheet of paper. The galvanometer used is a Holden-d'Arsonval reflecting, and, being rather too delicate, a resistance of German silver wire is inserted in the circuit.

Mr. Stansfield's arrangement of the photographic plate seems rather crude compared with our arrangement, which is a sheet of rapid bromide paper wrapped round a drum which is revolved by clockwork. I have used many kinds of pyrometers, but for simplicity and accuracy the thermo-couple is easily first. I should think that these pyrometers will be in use at many of the American blast furnaces for indicating the temperature of the blast. They are certainly far ahead of any other pyrometer in use. H. L. MUNNOCK.

Loftus, England.

Accuracy and Permanency of Switchboard Instruments.

To the Editor of American Electrician:

In the November issue of the "American Electrician" I notice an article entitled "Accuracy and Permanency in Switchboard

Instruments," in which it is stated that the electro-dynamometer principle constitutes an ideal form of switchboard instrument, possessing all possible virtues and no defects. I write to take exception to the statements made in the article, for I have had several years' experience in the manufacture of switchboard and portable instruments, and spent over a year in the endeavor to produce such a type of instrument as described for switchboard use, but found that it was thoroughly impracticable.

To start with, the dynamometer system is more susceptible to the influence of external fields than any form of instrument I have ever tested, and, when used on direct current circuits, it is necessary that the direction of the current flow should be reversed and the mean of the two readings taken in order to ascertain the actual current flow. This in itself is sufficient to prohibit the use of such an instrument on direct-current switchboards. If an attempt is made to shield such an instrument by the employment of an iron case, a certain amount of shielding will be effected, but the instrument will be seriously in error when employed on the alternating current; that is, there will be from 2 per cent to 5 per cent difference in the indications of the instrument for the same potential, depending on whether that potential is direct or alternating, and the necessity of reversing the direction of the current flow on direct current still remains.

Considering the question of a voltmeter, it is necessary to construct the moving coil so that it will have small weight, and, if this is done, it will be found that, if the axis carrying the moving coil is set horizontally, after some weeks of service the coil will become deformed and errors will be introduced in the readings. The alternative is to place the axis of the moving coil vertical, which involves a very awkward construction and a badly placed scale.

For ammeter use a serious objection is encountered when you consider the fact that it is necessary to place the moving coil in series to the fixed coil, and provision must be made to carry the current from one to the other. Consider for a moment the difficulty which would be experienced in providing a perfectly flexible and frictionless connector capable of carrying 1000 amperes. Such a connection has never been successfully made, except by the use of mercury contacts, only applicable to a vertical type of instrument, as exemplified in the commercial laboratory dynamometer of to-day. Again, if one has had any experience in using the laboratory dynamometer, he will understand the many precautions necessary to insure absolute accuracy. Tests and corrections must be made for the influence of external fields, the difference in the self-induction of the fixed and moving coils on alternating current, and the influence of iron in the framework of the instrument or in its immediate vicinity.

As a shunt instrument, the electro-dynamometer is distinctly not a success, since the resistance is entirely too high for the quantity of current necessary to operate it, and a shunt block would have to be constructed which would permit an abnormal flow of the current across its terminals at a drop which would be prohibitive. For instance, the best results which I have seen in the attempt to produce a shunt instrument on the dynamometer principle required a drop of 10 volts and a current flow of .05 of an ampere. These two factors may be changed, but the watt energy required remains constant. Attempts have been made to utilize the drop in the fixed coils to actuate the moving coil, and this again has resulted in absolute failure, for the reason that an energy of about 5 watts is essential to carry the pointer to full scale, and this amount of energy requires a drop in the fixed coils which would necessitate the introduction of a large resistance into the series circuit.

Again, it is stated in the article that an equally divided scale can be obtained "by the ingenious placing of the counterbalance or the employment of several weights successively brought into play." In this connection I would say that there may be such a method, and if there is I would appreciate details. A vast amount of money and time has been expended in the attempt to produce an instrument on the electro-dynamometer principle which would have a practically equally divided scale, but up to date I have never heard of a single successful result. If one bears in mind the fact that the deflection of the pointer in such an instrument is proportional to the square of the current, he will appreciate the impossibility of producing an equally divided scale unless the moving coil and fixed coil are separately excited, in which case we have a wattmeter rather than a voltmeter or ammeter.

For portable instruments I am willing to grant you that the dynamometer system is absolutely ideal, that is, so far as wattmeters and voltmeters are concerned, but it is not practicable in the case of portable ammeters, except in the commercial form of an electro-dynamometer with mercury contacts and leveling screws. Such a line of instruments the company with which I am connected have been making for a number of years with most excellent results as to permanency and accuracy; the voltmeter having a scale which starts at about 1-10 the total reading, while the wattmeters have an approximately equally divided scale, the scale divisions being rather smaller at the start and finish than in the center.

If you will look into the past and present history of switchboard instruments you will find that the electromagnetic type has proved itself eminently satisfactory when properly constructed. It is true that there are many types on the market to-day in which serious errors due to lag or hysteresis exist, but this is the fault of the designer or constructor, rather than the fault of the general principle employed. Scientifically accurate results and absolute permanency of calibration may be obtained by the employment of the electromagnetic system, if the design is correct and all the various component parts properly selected and treated. Very truly yours,

Philadelphia, Pa. J. F. STEVENS.

[Replying to Mr. Stevens' communication, I will take up his objections in order. The dynamometer is indeed susceptible to external fields, but this is true of any instrument. Even a highly magnetized d'Arsonval type is also thus susceptible, and must be carefully placed on the switchboard with reference to minimizing such an effect. It is not at all uncommon to find the voltmeter in a station removed from the main switchboard and at a distance from the generators, to avoid the influence of stray fields. The ammeter, which is of less importance, is usually left on the switchboard.

The influence of magnetic fields can be largely eliminated by the use of a heavy iron casing, which should be properly made so as not to introduce errors. It should be large, thick and of soft homogeneous material. These are by no means impossible conditions, commercially or practically; nor does the added weight constitute an objection. When used for alternating currents, the dynamometer is unaffected by magnetic fields and needs no shield.

It is not to be presumed that a switchboard instrument could be used without change for both direct and alternating currents, but the only requirement necessary to adapt an instrument to measure either would be to change its containing case and its scale. This a manufacturer of instruments should find no hardship, and it seems to the writer that it would be cheaper and easier to build different types of containing cases than to build different types of mechanisms.

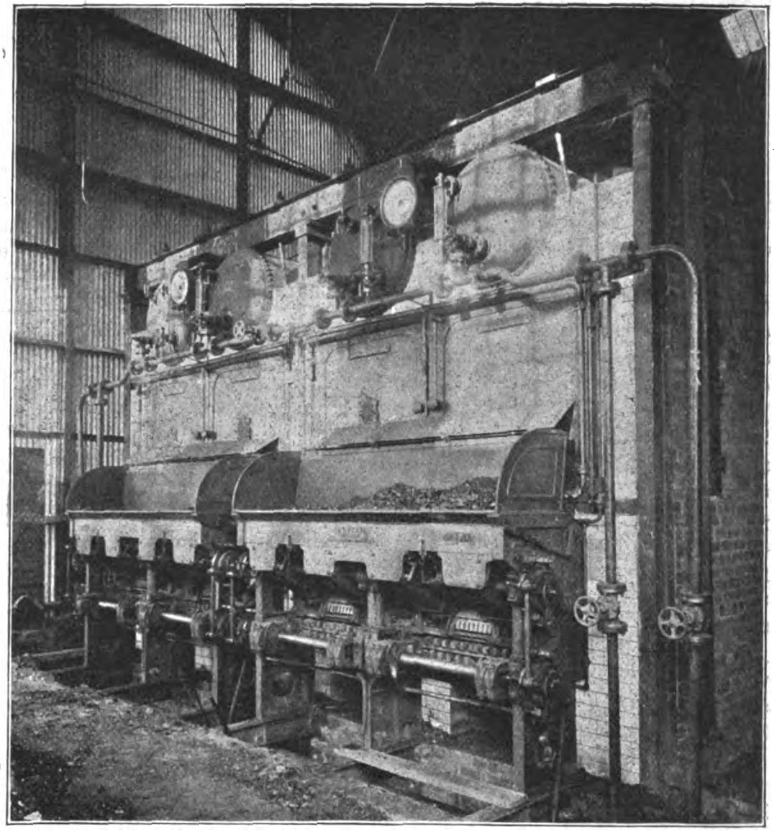
The statement that if the moving coil is made light enough for voltmeter purposes it is likely to be deformed, is somewhat of a surprise to me. From the very nature of the instrument the forces which act on the dynamometer coil must be minute, and it ought not to be difficult to build a coil stiff enough to resist them. The statement that it is impossible to have a mercury contact combined with the horizontal axis of rotation is also a surprise to me. In the "American Electrician" for November, in Figs. 1 and 2, page 510, is illustrated an electro-dynamometer mechanism constructed with a horizontal axis and mercury contacts, and, as far as this method of making contacts is concerned the writer's experience has been that it is very successful, although in instruments which are to indicate over 300 or 400 amperes it would not be suitable. When such a large amount of energy as this is measured the percentage of energy that it is permissable to use becomes quite a liberal quantity, and sufficient to actuate dynamometers on the shunt plan.

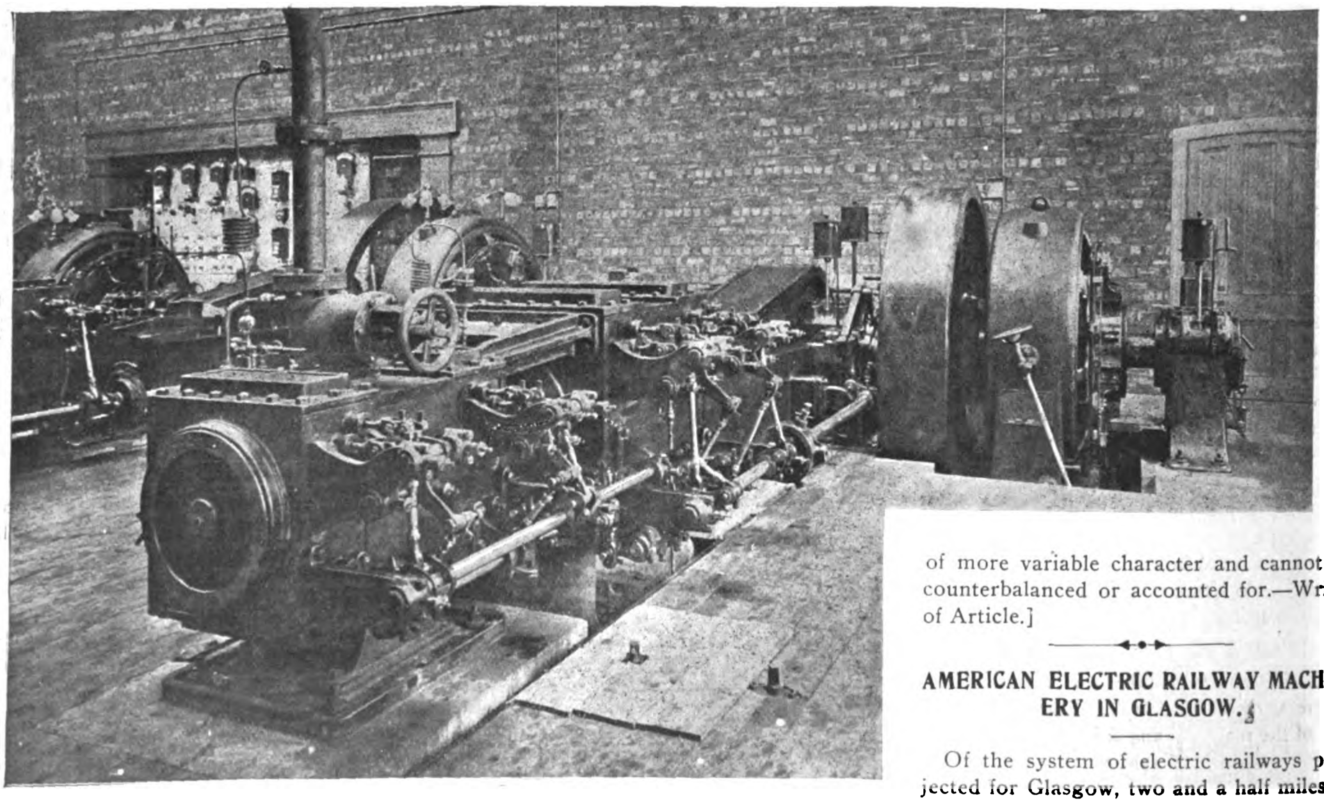
Regarding the statement that the ingenious placing of counter weights will give an evenly divided scale, I would say that the simple device of a cam placed on the shaft and winding up on its surface a cord carrying a weight can be constructed, which will easily follow the intricacies of the square function and much more complicated ones. The contour of the cam is a mere matter of mathematics.

Regarding what Mr. Stevens says about his portable instruments, I would suggest that it is perhaps the key to the cause of his criticism of dynamometer switchboard devices, and his standard of accuracy, while highly creditable from a technical standpoint, is not commercial. The excellent results which he has attained with portable instruments has led him to be loath to accept anything inferior in switchboard instruments, while as a matter of fact the public will not pay for absolute accuracy in switchboard instruments, and possible errors of from 2 to 5 per cent are accepted if economy in the first cost can be obtained.

As far as the past and present history of the electromagnetic instruments is concerned, the writer's experience has been that they are anything but satisfactory, as they all contain moving iron. Iron has a very apt and retentive magnetic memory, and the deflection of the instrument depends as much upon what has been previously indicated as upon what it ought to indicate. If Mr. Stevens has himself been successful with electromagnetic instruments and produced types in which errors from lag and hysteresis are not appreciable, I think the electrical fraternity will agree that he ought to be congratulated as a pioneer.

To sum up, an electro-dynamometer, like other instruments, should be removed from magnetic influences as far as possible, and can be shielded from them. It can be made sufficiently strong to withstand deflecting forces and still pass as a commercial instrument. A type can be selected in which the mechanism is so constructed that it can be built as a voltmeter, an ammeter and a wattmeter, and when once properly installed, need not be recalibrated. It can be made cheaply. The very fact that Mr. Stevens has succeeded in perfecting it as a portable instrument argues its possibility for switchboard work, for with a portable instrument the requirements are made more exacting, the magnetic fields and other disturbing influences are strong and of more variable character and cannot be counterbalanced or accounted for.—Writer of Article.]


AMERICAN BOILERS IN GLASGOW POWER HOUSE.


AMERICAN GENERATORS AND ENGINES IN GLASGOW ELECTRIC RAILWAY POWER HOUSE.

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AMERICAN ELECTRIC RAILWAY MACHINERY IN GLASGOW.

Of the system of electric railways projected for Glasgow, two and a half miles of double track have recently been completed and opened for traffic. Of particular interest to America in connection with this railway, is the very large use in its construction of American apparatus and material. The engines were made by the McIntosh, Seymour & Company of Auburn, New York, and are three in number, of the horizontal tandem-compound type and an indicated horse-power of 300 to 450. The steam generators are Babcock & Wilcox boilers, two being at present installed, each of 250-h.p. capacity. Worthington condensers and Blake-Knowles pumps are employed. The trolley poles were supplied by Morris, Tasker & Company, of Philadelphia, and are of a particularly ornamental design. The electrical generators were furnished by the Westinghouse Company, and are three in number, of the Westinghouse eight-pole 200 k.w. type of 380 amperes at 550 volts. The switchboard is also of Westinghouse type and equipped with Weston voltmeters and ammeters. The cars are equipped with Westinghouse No. 39 motors, with Westinghouse controllers, switches, circuit breakers, lightning arresters, etc. It will thus be seen that with the exception of the cars, every important feature of the operating plant is of American manufacture. The accompanying illustrations show the steam and generating plants.

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NOTES.

Electrical Excavator.—The London "Engineer" in a recent issue describes an electrical excavator used in excavating in the tunnel of the Central London Railway. This was specially designed to suit the clay found on this section of the undertaking, where large boulders up to 3 ft. and 4 ft. in diameter were encountered. Any machine constructed on the principle of the rotary cutter was out of the question in dealing with such material. The machine consists essentially of a dredger ladder, the working end of which can be moved vertically, horizontally and longitudinally, each motion being so arranged that a slow definite feed can be given, and so that a point of the ladder having been moved to any position in the face is rigidly held down. The ladder itself is 17 ft. long, and is provided with an extension screw arrangement for keeping the bucket chain tight. The buckets, of which there are 37, consist of a bottom and back only, the back being fitted with teeth. These teeth are of wrought iron, chisel-pointed, and dropped into recesses cast in the back of the buckets. About 6 ft. from the driving tumbler end of the dredger the ladder is supported by two chains passing to the winding longitudinal shaft. The fore-and-aft traveling gear is worked from a pulley on the other end of the motor which drives through the king post by the countershaft and worm gearing. Two barrels are placed one of each side of the under frame. From these barrels wire ropes are led fore and aft of the machine and fastened to the sides of the tunnel. Each of these traveling, raising, slewing and fore-and-aft motions is worked by means of worm gearing, so that without the use of a brake the point of the ladder is held definitely wherever the feed takes it. The lever for working the motions, the reversing switch and the ten-way switch for turning on the current, are brought together within easy reach of the driver, who stands on a small platform at the left side of the machine. When the machine had been in use for two or three months, the time occupied in pushing the shield and erecting the iron was very much reduced, and during the last few weeks' work of the machine eight rings were put in several times during the two shifts. The average number put in, however, was three 20-inch rings per shift of ten hours. The number of men at the face, including the driver, was usually eight, but was reduced latterly to six. The number of men employed at the same work by hand was fourteen.

DATA OF TRANSFORMERS.

	One.	Two.	Three.	Four.	Five.	Six.
Output in kilowatts						
Primary p. d., in volts						
Secondary p. d., in volts	5	5	5	3	3	8
Frequency of alternations, in periods per sec.	2000	2000	2000	2000	2000	2000
Maximum secondary current, in amperes	100	100	100	100	100	100
Cross-section of secondary wire, in sq. cms.	100	100	100	100	100	100
Maximum current density, in amperes per	50	50	50	30	30	30
sq. cm	0.383	0.383	0.383	0.204	0.204	0.204
Number of convolutions in the secondary						
Ratio of mean to maximum ohmic loss	130.5	130.5	130.5	147	147	147
Ratio of mean to maximum hysteresis loss	48	34	35	24	42	45
Thickness of core plates, in mils	0.835	0.835	0.835	1	1	1
Thickness of insulation between core plates,	0.99	0.99	0.99	0.985	0.985	0.985
in mils	13.3	13.3	7	15	15	7.5
Maximum ohmic loss, in watts						
Maximum hysteresis loss, in watts	1.7	1.7	1.7	1.85	1.85	1.85
Maximum eddy-current loss, in watts	100	94.8	89.5	60	63.6	58 3
Maximum total loss, in watts	79.5	76.8	87.4	81.5	59.3	67.2
Mean total loss, in watts	20.5	16.0	5.7	20.5	15.2	6.3
Magnetic induction in iron, in lines per sq.cm.	199	187	181.6	160.5	137	129.7
Weight of copper, in lbs	182.5	171.1	167	160.5	137	129.7
Weight of iron, in lbs	3900	2290	3130	2670	2810	4400
	61.5	58.5	55	29.2	30.9	28.4
Drop of secondary voltage at full load, due to	130	294	202	230	153	87
copper losses only, in volts	2	1.9	1.79	2	2.12	1.95
Radiating surface per watt wasted, at full						
load, in sq. inches	3.75	5.3	4.9	5.0	4.6	3.85

Design of Transformers.—A highly mathematical paper by Mr. Frederick W. Carter, entitled "The Design of Transformers," was read at the November meeting of the American Institute of Electrical Engineers, in which the author attempts the useless, if not impossible, feat of laying down a system of transformer design consisting entirely in the use of equations, more or less complicated. The accompanying table is taken from the paper, giving the data of six transformers, columns 1 and 4 relating to types of commercial transformers, and the other columns to designs calculated by the author.

Co-Operative Electro-Technical Research.—The Council of the American Institute of Electrical Engineers has appointed a committee on "Co-Operative Research," whose duty it will be to suggest problems for research and submit them for investigation to the various colleges and other laboratories, the results to be published by the Institute. The following is a list of the investigations thus far suggested:

(1) The effect of sustained high temperature upon the insulation resistance of dielectrics. (2) The influence of sustained high temperature upon the dielectric strength of insulating materials. (3) The influence of sustained high temperature upon the hysteretic coefficient of commercial iron. (4) The influence of chemical impurities in iron or steel upon the hysteretic coefficient. (5) The hysteretic coefficient of magnetic alloys. (6) The temperature coefficient of resistivity in commercial copper wires. (7) The temperature coefficient of resistivity in commercial aluminum wire. (8) The temperature coefficient of resistivity in alloys commercially employed (it is desirable to include analysis of the alloys tested as well as their physical properties). (9) The highest conductivity obtainable in copper wire at any standard temperature. (10) The highest conductivity obtainable in aluminum wires at any standard temperature. (11) The analysis of dielectric losses between parallel copper wires maintained at high e.m.f.; 1, alternating and, 2, continuous, into component parts, such as chemical, electrical and mechanical. (12) The influence of wave form of alternating e.m.f. upon the dielectric strength of dielectrics. (13) The influence of wave form of alternating e.m.f. upon the sparking distance between needle points in air. (14) The influence of the room temperature upon the temperature elevation of dynamo machines under a given load, as computed from their increase in resistance under load. (15) The distribution of temperature elevation in field coils of dynamo machines, as dependent upon their form and dimensions. (16) The relations between the "load loss" and "short-circuit core loss" of an alternator. (17) the counter-e.m.f. of electrolytic deposition cells at potential differences ranging between the maximum polarization voltage and zero. (18) The seat of the increased counter-e.m.f in storage cells during rapid discharge. (19) The magnetic properties of alloys containing iron, nickel and cobalt. (20) The magnetic retentivity of powerfully twisted iron and steel wires, or of magnets composed of such twisted wires. (21) The permeability of magnetic materials at low values of magnetizing force. (22) The dielectric strength of different substances employed for insulating, at different frequencies of alternation. (23) The influence of very high frequencies of alternation upon the sparking distance between needle points in air (the highest attainable frequencies preferred). (24) The dielectric strength of vapors of different substances. (25) Influence of wave form upon efficiency of rotary converters. (26) The influence of magnetic field upon electrolytically deposited bismuth. (27) The conditions giving rise to sparking at commutators.

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An Electrical Paradox.

On other pages of this issue we print a number of communications brought forth by a letter in the preceding issue, describing an apparent electrical paradox. The subject is so thoroughly elucidated in the letters printed, particularly in that of Mr. Carl Hering, that comment is unnecessary. It might be added, however, that the paradox considered, as well as other strange conclusions sometimes arrived at concerning electrical circuits, are due to directing attention to a local part alone of a circuit, and having no eye as to the manner in which the entire circuit, and consequently the current, are affected by a change in any part. It should be borne in mind that the current in a circuit, the e.m.f. and the resistance are bound up together, and that if a change in any one of these factors is made the effect can only be determined by calculations considering all three—that is, the circuit in its entirety.

The Electrical Transmission of Power.

In another column we print a description of the transmission plant at Cañon City, Colo., the article being from the pen of Mr. Ralph D. Mershon, chief engineer of the plant during its construction. This installation has many features of interest, not the least notable of which is that it distributes power generated by steam, the economy lying in the many small units supplied, the intermittent work in most cases, and the fact that otherwise coal taken to the Cripple Creek gold camp would have to be freighted to a high altitude at considerable cost. As the views of the line show, the line construction was of an unusually difficult nature, but here, as in every part of the installation, the work was carried out in the most permanent manner. A novel feature of the installation is the use of a compensator system, which indicates at the station the voltage at the receiving end of the line, taking account of current, power-factor, reactance and resistance, but not employing a pressure wire extending to the receiving end. An account of this system will be found in an article by Mr. Mershon, in our issue of June, 1897.

Decorative Incandescent Lamps.

Since the advent of the electric sign, incandescent lamps have been largely used for decorative purposes, and very frequently at great expense, for many lamps are required to form the necessary designs. Moreover, the wiring and fixtures add to the first cost, while the constant renewal of lamps is no small item. Incandescent lamp manufacturers are always seeking for an attractive novelty and also for a good high-voltage lamp, and it happens that both these two qualities may be very happily combined in a single construction.

The standard practice in lamp filaments has been to shape them in the form of a loop or coil between two adjacent terminals. It does not seem by any means an impossibility to stretch the filament in a straight line in a tube connecting two terminals at either end thereof. The construction is certainly cheap, and practically very feasible. One of the most prolific sources of failure in high voltage lamps is the inability of the filament to retain its shape. It either droops against the glass or, after continued use, springs apart from its own tension. The first lamps were made with straight filaments on the old hack saw plan, simply because it was easier to do this, and the carbon had a longer life; and while the modern lamp is a triumph of expert construction with its long filament in close, compact form, this has been achieved rather at the expense of the life of the filament than otherwise.

The electrician who is using incandescent lamps for decorative purposes would welcome the advent of long straight tubes with terminals at either end, containing straight filaments. Lamp manufacturers can now easily construct lamps of this kind, not only for 220 volts, but even higher voltages. It is difficult to conceive of anything better for lighting show windows or bordering electric signs, or even, with the aid of some curved tubes, for tracing out the contour of letters. There is certainly opportunity here for a novel and long lived lamp, whose use in display illumination will cut down the cost of wiring, the number of connections and section of conductors.

Tesla and His Critics.

We have received from Mr. Nikola Tesla, with a request that it be printed in our columns, a letter containing a personal attack on the editor of one of our electrical contemporaries. Owing to the personalities contained, which form the greater part of the letter, we regret that our editorial policy will not permit us to print the communication in full, and we will therefore only notice such parts as may be considered to have a journalistic or public bearing.

Mr. Tesla accuses our contemporary of having done him an injury by reprinting in its columns a paper read by him before a medical society; and of having cast a shadow on his honor and attacked his honesty in an editorial comment apropos of the said paper. Aside from their personal bearing, these charges involve the right of a journal to reprint matter that has passed out of the hands of a writer and become, through publication, the property of the world at large; and the right to criticise, as a professional journal, public announcements of scientific discoveries pertaining to the profession which it represents.

As to the first charge, our contemporary in answer prints satisfactory evidence that the republication in its columns of the paper in question was authorized by the chairman of the medical society before which it was read. Even in the absence of such authorization, however, it is difficult to see what justification there can be for Mr. Tesla's statement: "By publishing in your columns of Nov. 17 my recent contribution to the Electro-Therapeutic Society, you have finally succeeded * * * in causing me a serious injury." The paper was presented before a national professional body, and, therefore, it is to be presumed, was maturely composed by its author with a knowledge that such presentation constituted publication to the world, and laid the statements contained open for comment or criticism from any source—not even excluding an electrical journal.

As to the second charge, a careful reading of the editorial upon which it is based leaves only the impression that the writer was actuated by a kindly motive in reminding Mr. Tesla of the many unfilled promises he has made to the public in recent years—promises of light without heat, a revolution by means of his "oscillator" in the generation of electrical energy, the transmission of electricity without wires, the destruction of fleets by means of an application of the coherer—to which list might have been added the expulsion of microbes by means of an electrification of the body and other announcements which, with those noted, have earned for Mr. Tesla the popular title of "The Wizard." Surely this constituted a legitimate subject for editorial comment by an electrical journal, and the manner in which the warning was conveyed—that Tesla had arrived at the stage when fulfillment of some of the many promises made had become vitally necessary to his reputation—was not such as to call for a violent attack on his critic.

The truth plainly stated is, that for several years Mr. Tesla has only escaped similar criticism in professional and scientific journals on account of the high esteem in which he is held personally, and through recollection of the magnificent boon he bestowed on the world by the invention early in his career of the polyphased system. The manner in which he has permitted himself to be exploited by the sensational newspaper press has been a source of pain to his friends, and has largely alienated from him the sympathy of the electrical profession. Moreover, his periodical promise of being on the point of accomplishing some wonder that would revolutionize electrical science has had an untoward effect on the electrical industry, for among laymen it has tended to produce the belief that at any moment one of Tesla's great discoveries may materialize and destroy all present investments.

The Efficiency of Small Motors.

In the early days of motor construction the chief aim of manufacturers was to produce a machine that would really run, drive some load and not burn up every few days. In the case of very small motors, what load they would drive or what current they would require and stand were matters usually determined after the machine was built. Efficiency was not considered or even mentioned—the gilt striping on the magnet was infinitely more important. The armature core was of cast-iron, the coils few but not far between, and the magnet yoke had about one-eighth the cross-section of the core. This sort of thing was built in sizes as large as half a h.p. until the clamor for serviceable and moderately efficient motors of 1 h.p. and under resulted in the construction of machines from fan-motor size up, with laminated armature cores and a "real dynamo style of magnet." Efficiencies then rose from a negligible figure to 15 and 20 per cent. The design of both small and medium size machines—up to 10 h.p. capacity—steadily improved up to a few years ago, when the improvement apparently stopped. Since 1894 the efficiency of small motors has remained at about 40 per cent for a ¼ k.w. motor, 50 per cent for 1 k.w., 60 for 3 k.w., and so on.

One reason for this undoubtedly lies in the fact that changes in design are expensive to a factory producing a complete line of machines. In some cases it is simply poor designing that keeps down efficiencies. Among actual instances recently noted of comparatively small changes in design which resulted in material increases in efficiency and satisfactory operation were the following: Increasing the width of the armature teeth and decreasing the number of turns per coil; changing the shape of the pole-shoes and reducing the length of the air-gaps; increasing the area of the magnetic path in the armature core; extending the pole-shoes and decreasing the number of turns per armature coil; increasing the cross-section of the field magnet yokes, and decreasing that of the magnet core, at the same time increasing the depth of the field winding and decreasing its length along the core, so that even less expense for field wire was incurred than before. In no case was the speed increased and in one it was reduced.

Young designers are very frequently hampered by the concentration of effort upon one or two hobbies, to the exclusion or neglect of other equally important features. In all the cases above cited this class of error was prominent. One designer subordinated his ideas to the fact that the saturation of armature teeth produces a "stiff" field, and introduced so much reluctance there that the flux was throttled, the leakage was abnormal and too many armature wires had to be used to keep the speed down; another allowed the fear of sparking to exaggerate the length of the air-gap, not knowing that the simple expedient of saturating one pole-tip was a preferable substitute. Still another endeavored to economize by unduly reducing the cross-section of the magnet yoke in order to compensate for an unnecessarily large core; reversing his reasoning reduced the reluctance and the leakage coefficient, thereby reducing the ampere-turns required on the magnet—as well as the quantity of copper per ampere-turn.

There is no reason that the public will accept for the limitation of motor efficiencies to the figures mentioned above, and the most ignorant (technically) of motor users are rapidly becoming critical regarding the efficiency of small machines. Owners of industrial establishments in which motors are used on meter service, although devoid of the remotest conception of kilowatts, half-load efficiencies and other technicalities, evince lively appreciation of a motor that runs up a bill of $20 a month as against $25 paid for the service demanded by another machine of the same rating. Even among the least educated of power users in New York and other large cities the basis of judgment that is rapidly becoming general is not the cost of the motor, but the amount of energy it is going to waste. The prospective buyer does not thus express his anxiety concerning the meter bills, but that is the technical translation. As the losses in a motor are nearly the same at all loads, and as motors are almost invariably used in a class of industries to the success of which rigid economy of operation is indispensable, the efficiency is a more important matter, particularly in meter districts, than manufacturers appear to realize.

DESIGNS FOR SMALL MOTORS.

ONE HORSE-POWER BIPOLAR MOTOR, WITH DRUM ARMATURE.

BY CECIL P. POOLE.

The accompanying drawings and description will enable anyone with moderate machine-shop facilities to build a 1 h.p. motor to work on a 110-volt or a 220-volt continuous-current circuit. Two types of field magnet are given, the armature and shaft being the same in both cases.

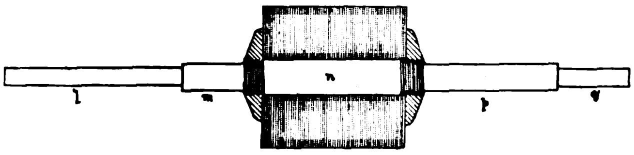


FIG. 1.—ARMATURE CORE AND SHAFT.

The armature is 4 ins. in diameter, outside, with twenty-four slots, each 7/32 in. wide and ⅝ in. deep. Fig. 1 shows the shaft and a cross-sectional view of the armature core. The discs are compressed by two cast-iron end plates, which are screwed on the shaft; these plates are ½ in. thick at the shaft, and taper to 3/16 in. thick at the outer edge, which is rounded as shown, to avoid abrading the insulation between the core and the windings. The full list of armature dimensions is as follows:

	Core, Body.	Heads.	Shaft. at l.	m.	n.	p.	q.
Diameter	4	2¾	½	¾	1"	¾	½
Axial length..	4	½	5	1¾	5"	3¾	2

The discs should have a shallow key-seat in the edge of the central hole, and the shaft should be correspondingly key-seated, and a spline, or perfectly straight key, ¼-in. square, should be used to transmit the movement of the discs to the shaft. If this is done, the slots in the periphery of the discs may be milled out; the armature core must be dismantled after the slots are cut, and the burr which is left by the milling cutter smoothed off. If the key and key-seats are properly fitted the discs will go back on the shaft in precisely the position in which the slots were cut, and the sides of the latter will be smooth. If the key is a loose fit, however, it will be advisable to use a straight edge in one of the slots to insure perfect accuracy in re-assembling the discs. It is scarcely necessary to urge a very careful and close fit of the key and its seats. In assembling the core, one of the cast iron heads should, of course, be screwed to place first; then put on a disc of vulcanized fibre, 1/16 in. thick, 4 ins. in diameter, and next thread on the iron discs. After the last iron disc put on another fibre disc and follow with the end plate or head of cast iron, which will have to be set up with a pin wrench. If the discs are purchased with the slots already stamped out notches will have to be cut in the fibre end discs to correspond with the armature slots; if the slots are to be milled the fibre discs will, of course, be cut along with the iron ones. The latter must be not over 1/32 in. thick and preferably thinner; care should be taken not to get steel discs, but the very best possible grade of charcoal iron.

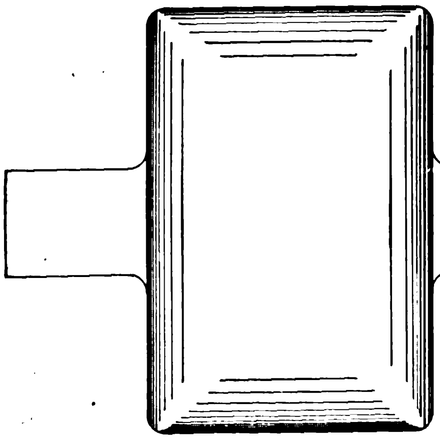


FIG. 2.—PLAN VIEW, IRON-CLAD MAGNET.

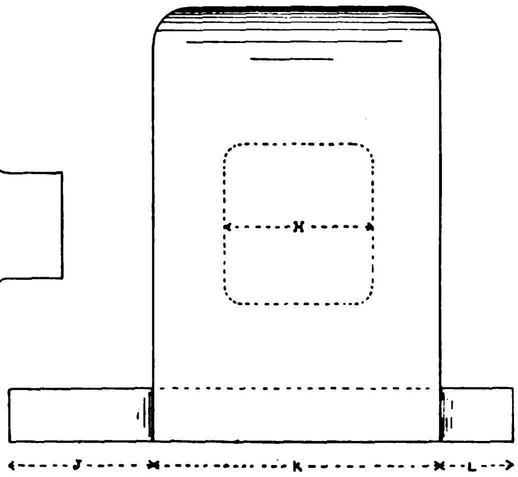


FIG. 3.—END ELEVATION, IRON-CLAD MAGNET.

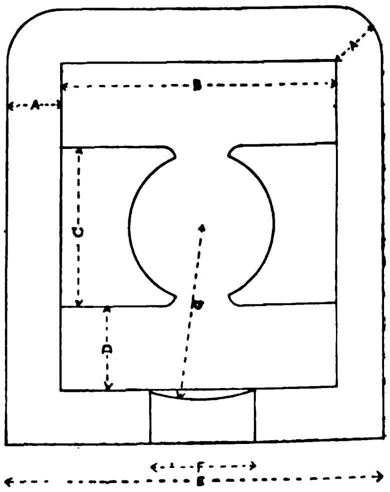


FIG. 4.—SIDE ELEVATION, IRON-CLAD MAGNET.

Of the two types of field magnets shown, the iron-clad is preferable from a constructional standpoint, as the only operations are boring out the armature chamber and the seats for the journal pedestals, and drilling the bolt holes for the latter. Fig. 4 gives a side elevation of the iron-clad magnet, Fig. 3 an end view and Fig. 2 a plan view. The thickness of the magnet core (the portion on which the coils are placed) parallel with the shaft is 4¼ ins. except right at the pole face, where it is rounded down to 4 ins.; this is necessary in order to reduce the flow of magnetism from the pole to the cast-iron end plates of the armature, which produces waste of energy by heating. The complete measurements of the field magnet are as follows:

	Inches
A—Thickness of yoke portion of magnet...	1½
B—Inside length of horizontal part of yoke	8
C—Vertical thickness of magnet core......	4½
D—Distance from core to yoke..............	2⅜
E—Total outside width of magnet frame..	11
F—Width of journal foot..................	8
G—Radius to which journal seat is bored.	4⅞
H—Horizontal thickness of magnet core (see above)	4¼
J—Length of journal foot, commutator side	4⅜
K—Width of magnet yoke or frame, axially	8¼
L—Length of journal foot, pulley side.....	2⅜

The bore of the pole pieces is 4 3/16 in. in diameter, and this figure must be rigidly observed for best results, as all the calculations are based upon this length of air-gaps. The above dimensions are intended to apply to a magnet made of the best grade of cast iron; Scotch pig should be used if it is obtainable, and if not, then the very best grade of soft iron. The casting should be allowed to remain in the mold until it is absolutely cold, care being taken not to remove any of the sand from about the magnet proper. The sand can be scraped away from the extreme end of the longer of the two pedestal feet, so as to enable the molder to ascertain when the casting is cold. It is frequently the case that a casting requires as much as two days to thoroughly cool, but it should not be disturbed before it is cold.

Figs. 5, 6, 7 and 8 give outside and cross-sectional views of the journal pedestal for this magnet; the two pedestals are alike in every particular, and when in position on the projecting feet of the field magnet frame their outer edges should be exactly flush with the ends of the feet. The pedestals are of iron; the base is curved to conform to the arc of the circle to which the upper surface of the foot is machined, and is ⅜ inch thick. The standard consists of two ribs at right angles with each other, each ⅜ in. thick, with their edges curved as shown. The box is of the ring-oiling type, with a single ring hung midway of the journal; the bushing is easily made from thin brass tubing, ¾ in. outside diameter, and with a very thin wall (not over 1/32 in.), babbitted to fit the shaft and having a slot ⅜ in. wide cut half way through it, midway between its ends. This bushing is shown in Fig. 12, which represents the bearing for the other type of magnet, to be presently described. The bushing is 1¾ ins. long; the oil ring is made of brass, one inch in diameter, inside, 1⅛ ins. diameter outside, and ¼ in. wide along the shaft. Reference to the side views of the journal pedestal will show a slot in the upper wall of the box portion, through which the oil ring is inserted before putting in the bushing. A cover should be provided for this slot to keep out dust, etc. The dimensions of the journal pedestals are as follows:

	In.
g—Length of base and journal box	2¼
h—Width of base	3
j—Outer diameter of oil reservoir	2
k—Axial length of reservoir, outside	1¼
Internal diameter of reservoir	2¾
Internal length of reservoir	1

The bore of the box portion of the pedestal must, of course, be made to fit snugly the outer diameter of the tubing used for a bushing, as the wall of the latter is too thin to admit of turning it down to fit a predetermined bore in the pedestal. After boring the pedestal to fit the bushing it should be mounted on a mandrel and its base turned to fit the circle of the foot on the magnet frame, namely, 9¾ ins. in diameter. Each pedestal should be fastened to the foot with two ¼-in. cap screws.

Fig. 9 gives a side elevation of a much lighter magnet, which may be used in connection with the armature above described, if the builder has sufficient skill and facilities to do the machine work accurately. The magnet core is a round piece of wrought iron, 3¼ ins. in diameter, with its ends turned down to 3⅛ ins. diameter for a distance of 4 ins. from each end; the total length of the core is 12¼ ins., so that the length of the untouched portion will be 4¼ ins. The pole pieces are of cast iron, only the very best possible grade being suitable. Where the core enters the cast iron the latter is 4 ins. square, with the corners rounded, and having two ribs or flanges, f, f, running along one edge; these continue clear up to the top of the pole piece, and are 1 in. thick by 2 ins. wide. Fig. 10 shows an end view of the magnet frame, and Fig. 11 a plan view. The hole occupied by the wrought iron core should be cored out to 2⅞ ins. diameter when the casting is made, and afterward bored to a driving fit of the end of the core.

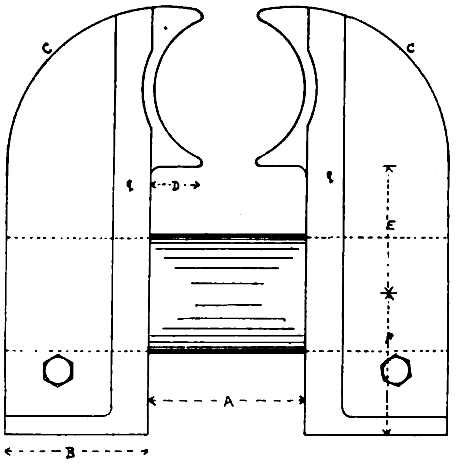


FIG. 9.—SIDE ELEVATION, SINGLE-COIL MAGNET.

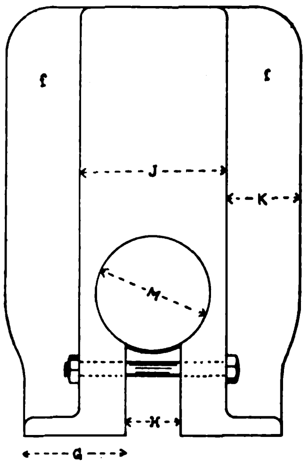


FIG. 10.—END ELEVATION, SINGLE-COIL MAGNET.

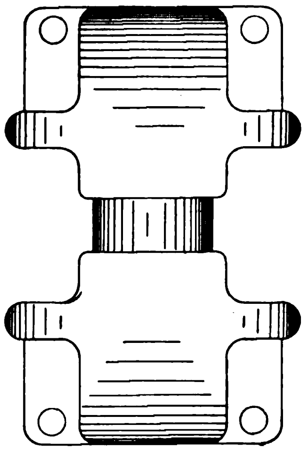
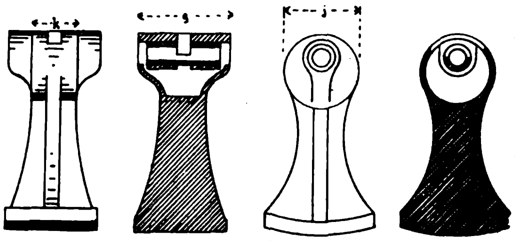


FIG. 11.—PLAN VIEW, SINGLE-COIL MAGNET.

The first operation should be turning off the ends of the core; next, bore the holes in the pole pieces (or, more strictly speaking, the yokes). Then drill a ⅛-in. hole through the yoke just below the lower edge of the big hole and at right angles with it, to accommodate the clamping bolt shown in Fig. 10. Next drive one end of the core into one yoke and set up the nut on the end of the clamping bolt; then put on the other yoke and twist it on the core until the four horns of the pole pieces are exactly opposite each other, tighten up the second clamping bolt, and plane off the bottom surfaces of both yokes. To bring the pole horns into alignment, the simplest method is to cut out two heavy blocks of hard wood, say 3 ins. thick and 3½ ins. square; bore a ½-in. hole through the center of each block, run a ½-in. bolt, 12 ins. long, through the two blocks, and apply them to each side of the pole pieces, the bolt passing through the armature chamber in about the position to be occupied by the shaft. Set up the nut on the bolt until the blocks are hard against all four pole horns, and then tighten up the clamping bolt in the foot of the loose yoke.



FIGS. 5, 6, 7 AND 8.—SIDE AND END ELEVATIONS AND CROSS SECTIONS OF JOURNAL PEDESTAL.

After planing off the feet of the frame, bore out the armature chamber 4 3/16 ins. in diameter, and the seats for the journal yokes (in opposite faces of the side flanges, f, f), 5 ins. in diameter, and then remove one magnet yoke and put on the magnet coil. If the coil is separately wound in a form (which is preferable) only one yoke need come off; if it is wound directly upon the core, both yokes must come off, of course. The base of the machine must be of wood or brass. Wood is better, as, aside from its cheapness, it affords convenient space for the terminal posts and fuse-block of the machine. The base should be 15 ins. x 18 ins., made of two pieces of hard wood each 1½ ins. thick, glued and screwed together with the grains at right angles. The longer dimension of the base is to go parallel with the shaft, and the machine should be so set as to allow the pulley to overhang the edge of the base-board.

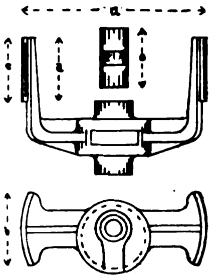


FIG. 12.—JOURNAL YOKE FOR SINGLE-COIL MAGNET.

The pulley should be 4 ins. in diameter and 2 ins. wide on the face; the latter should be crowned. The pulley should preferably be keyed to the shaft, with a set-screw in the pulley hub on top of the key. If only a set-screw be used to hold the pulley on the shaft, a "flat" must be filed on one side of the shaft under the point of the set-screw.

The journal box and yoke for this magnet is shown by Fig. 12. It must be made of brass or some other non-magnetic composition. The design and dimensions of the oil reservoir, journal box and bushing are exactly the same as those given for the journal box of the iron-clad magnet above. All the dimensions are given below, along with those of the magnet last described:

	In.
A—Distance between yokes	4¼
B—Thickness of yoke	4
C—Radius of outer curve of pole-piece	4¼
D—Length of pole horn	1⅝
E—Distance from pole horn to centre of magnet core	3¼
F—Distance from floor line to centre of magnet core	3⅞
G—Width of foot	2¾
H—Width of slot under core hole in yoke	1½
J—Width of yoke	4
K—Width of flange	2
a—Diameter of curve of journal yoke ends and seats	5
b—Vertical width of journal yoke arms	2¼
c—Length of machined portion of yoke arms	1¾
d—Distance from end of yoke arm to inner end of journal box, pulley end of shaft	2
—Distance from end of yoke arm to inner end of journal box; commutator end of shaft	4
e—Length of bushing	1¾
g—Length of journal box	2¼
h—Slot to let in the oil ring	⅜x1¼
j—Outer diameter of oil reservoir	2
Outer length of reservoir, axially	1¼

The windings for the armature and both of the magnets above described will be specified in the next article.

AMERICAN TELEPHONE PRACTICE.

BY KEMPSTER B. MILLER.

PROTECTIVE DEVICES.

In the early days of telephony, the fact discovered by Steinheil, that the earth could be used instead of the return wire of an electric circuit, was made use of, and telephone lines were generally constructed accordingly—that is, with but a single wire, using the earth as the return.

Lines so constructed were, however, soon found to be subject to serious difficulties, chief among which were the strange and unaccountable noises heard in the receiving instruments. There are many causes for such noises, some of which are not entirely understood. The swinging of the wire, in such manner as to cut through the lines of force of the earth's magnetic field, or the sudden shifting of the field itself, causes currents to flow in the line wire which may produce sounds in the receiver. On long grounded lines the variation in the potential of the earth at the ground plates, due to any cause whatever, will cause currents to flow in the line. The passing of clouds or bodies of air charged with electricity will induce charges in the line, and cause currents to flow to or from the earth through the receiving instruments. Electric storms, and auroral displays, apparently greatly heighten these effects. These noises are of varying character, and Mr. J. J. Carty well describes them in saying:

"Sometimes it sounded as though myriads of birds flew twittering by; again, sounds like the rustling of leaves and the croaking of frogs could plainly be heard; at other times the noises resembled the hissing of steam and the boiling of water."

The noises due to these natural phenomena, whatever their true cause may be, are chiefly annoying on long lines, short lines being disturbed only during heavy electrical storms. This is not the case, however, with the noises arising from the proximity of other wires carrying varying currents. Telegraphic signals can be plainly heard in a telephone instrument on a line running parallel with a telegraph line for a very short distance. The establishment of an electric railway, or electric lighting plant in a town using grounded telephone lines, will always cause serious noises in the telephones, and if the lighting current is alternating, the use of the telephones is usually out of the question at night time, while the plant is running.

Disturbances on telephone lines from neighboring wires may be attributed to one or all of the following three causes: Leakage, electro-magnetic induction and electrostatic induction.

Leakage may occur through defective insulation between the two circuits, or even when the insulation of the wires themselves is practically perfect; a heavy return current from a grounded circuit, such as of an electric railway, may, upon its arrival at the grounded end of the telephone line, have the choice of two paths, one through the telephone line, and the other a continuation of its path through the ground. This is the greatest source of trouble due to railway work, or grounded telephone lines. A strange fact in connection with this, is that the noises in the telephones do not correspond with the fluctuations due to the movements of the generator armature, as would be supposed, but to the movements of the armatures on the car motors. The tone in the receiver is an indication of the movements of the car, and variations in speed may be clearly noticed.

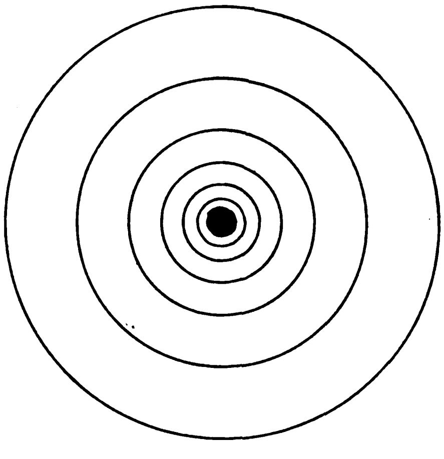


FIG. 1.—MAGNETIC LINES AROUND A CONDUCTOR.

Electro-magnetic induction is due to the fact that the telephone line lies in the field of force set up by the disturbing wire. About every wire carrying a current there is a field of force, or "magnetic whirl," consisting of closed lines of force surrounding the conductors. Such a condition is represented in Fig. 1. If the current is a continuous one, the lines of force will not vary after being once set up, and the telephone wire lying in this field will not be affected. If the current in the disturbing wire is fluctuating, the number of lines of force in this field will vary, or by a clearer way of expressing it, the field of force will expand and contract accordingly. This expansion and contraction of the field will cause its lines of force to cut the telephone wire, and will by the laws of electro-magnetic induction cause currents to flow in the latter. If the current in the disturbing wire is an alternating one, the field of force around it will be established in one direction, destroyed and established in the reverse direction and again destroyed, with every complete cycle of the current. It is easy to see that this will produce a maximum disturbance in the telephone wire.

Electrostatic induction may be explained by reference to Fig. 2, where a grounded telephone line is shown running parallel with a disturbing wire, which we will say is carrying an alternating electric current. The disturbing wire will receive from its source of current alternate positive and negative charges of electricity, and its potential will pass from a maximum in one direction through zero to a maximum in the other, twice during each cycle. Consider the condition where the potential of the disturbing wire is zero. No charge will then be induced on the telephone wire, so that its potential will also be zero. The charge on the disturbing wire then becomes, we will say, positive, and this induces a bound negative charge on the side of the telephone wire nearest the disturbing wire, and an equal positive charge on the opposite side. This latter charge is not bound, and flows to earth through the receivers at each end. This flow will be toward the ground through each receiver and the current is therefore from the center of the wire in each direction to the ground. The next instant the potential of the disturbing wire becomes zero, thus relieving the bound negative charge on the telephone wire, which flows to earth, or, more properly, is neutralized by a flow of positive electricity from the earth. Thus each change in potential of the disturbing wire causes a flow of current through the receivers at each end, this flow always being toward or from the middle point in the length of the wire. These currents produce noises in the receivers at each end in the ordinary way.

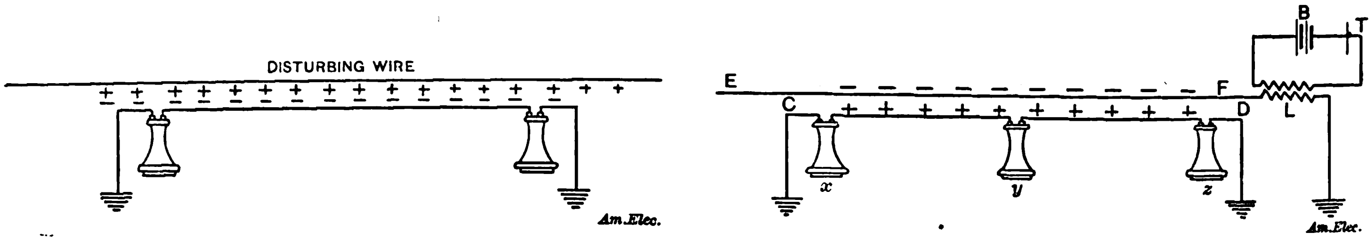


FIG. 2 AND 3.—ILLUSTRATING ELECTROSTATIC INDUCTION.

When two grounded telephone circuits run side by side, each acts inductively on the other, so that a conversation carried on over one circuit may be heard in the telephones on the other. This phenomenon is aptly termed cross-talk, and is usually explained in text books and articles on the subject by the supposition that it is chiefly if not entirely due to electro-magnetic induction.

In 1889, however, Mr. J. J. Carty, in a paper before the New York Electric Club, and again in 1891, in another paper before the American Institute of Electrical Engineers*, described a series of experiments which show conclusively that cross-talk between lines is due almost entirely to electrostatic induction, electro-magnetic induction playing so small a part as not to be noticeable.

The arrangement of circuits in one of his experiments is shown in Fig. 3, in which E F and C D are two well insulated lines, each 200 ft. long, and placed parallel with each other throughout their entire length, at a distance of ⅛ in. apart. E F is the disturbing line and is left open at E. At F it is connected through the secondary of an induction coil, L, with the ground. In the primary circuit of this coil is a battery, B, and a Blake transmitter, T. A tuning fork vibrating before the transmitter acted on the diaphragm in the usual way, and caused impulses on the line E F of practically the same strength as voice currents. These impulses are, of course, alternately positive and negative, and may be considered in the same light as the impulses on the disturbing line in Fig. 2. Three receivers, x, y and z, were placed in the line C D, the receiver y being at the middle point in the line. Upon operating the tuning fork its musical note could be distinctly heard in receivers x and z, while y remained silent.

In explaining the action of static induction in connection with Fig. 2, it was pointed out that the flow of induced currents would be either toward or from the middle point in the length of the wire. The silence of the receiver y in this case bears out that statement, showing the central point to be neutral. If this were electro-magnetic induction the induced current would pass from one end of the line, C D, to the other, returning through the ground, in which case all the receivers would be affected. As it is, however, the induced charges flow in each direction from the receiver y, to the ground at each end, or from the ground at each end to the receiver y, thus in no case causing its diaphragm to vibrate. The same results were obtained by grounding the point E through an ordinary telephone. The receiver wire still remained silent, while x and z were both affected to an equal degree.

It was also found that opening the central point of the line, C D, produced no effect whatever on the existing conditions; the noises in the receivers x and z were plainly heard and of equal loudness.

Many other experiments were tried, the results in each case pointing conclusively to the induction from voice currents being of an electrostatic instead of an electro-magnetic nature.

There is no doubt, however, but that induction from wires carrying heavy currents, such as are used in lighting and power work, is largely due to electro-magnetic effects, and this can be easily proven by experiments similar in nature to those described.

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* These papers are almost classics and should be read by all interested in this subject.

INTERIOR WIRING.

FEEDERS AND MAINS.

BY CHARLES E. KNOX.

In discussing the feeders and mains in the last article, and also in previous articles, no special mention was made of mains. Inasmuch, however, as a main may be considered as a prolongation of a feeder in the nomenclature we have adopted, what applied to a feeder would, with certain modifications, also apply to a main.

Having discussed the various points to be considered in adopting a system of feeders and mains, let us suppose we have reached a point in laying out the wiring where the branch circuit work is mapped out, the location of the various distributing centers and rising shafts has been decided upon, and there only remains the planning of the arrangement of the feeders and mains.

If the building has more than one story, the first thing to be done is to make an elevation of the building, showing the height and number of stories. On this elevation the various distributing centers should be indicated diagrammatically, but with a view to keeping their relative arrangement as near as possible to their actual arrangement on the different floors.

Having done this, it is necessary to decide two questions (mentioned in last article) before proceeding further. These are, first, whether the hall or public lights will be controlled separately or together with the private lights from the main switchboard, because the settlement of this question will affect the arrangement and the number of the feeders and possibly of the mains. Let us first consider those cases where no distinction is made (so far as the feeders and mains are concerned) between the private and the public lights. The second question to be decided is whether there will be several floors supplied by one feeder, or whether there will be a separate feeder for each floor. We will first assume that there will be a separate feeder for each floor. As these questions were discussed generally in the last article we will not consider them here, except as to the method of procedure in arranging the feeders and mains in the various cases.

It seldom happens that more than one feeder is required for any one floor, but sometimes this may be necessary, as in the case of a hotel where a portion of one floor may be occupied by a ball-room or restaurant, or in a public building in which part of one floor may be devoted to the purpose of a lecture hall or auditorium. In such instances it is generally desired to control these rooms separately. They may then be treated as if they were separate floors.

With our elevation and the floor plans before us, we proceed to mark at each distributing center the number of lights supplied by the branch circuits starting from that center. This being done, a tentative lay-out of the mains running from the feeder center to the various sub-centers should be made.

Having done this, the next step is to find the number of lights supplied by the feeders and the mains. In the case of the feeders this is equal to the sum of all the lights supplied through the distributing centers on the floor, since we are now considering that they are all supplied by one feeder. In the case of a main, the load is, of course, equal to the number of lights supplied through the distributing centers, which are fed either by the main directly or by a prolongation of the main.

Having obtained the load of the feeders and mains, the next step is to get their estimated length. To do this, the horizontal length is first obtained by reference to the floor plans; the vertical length is estimated from the elevation of the building. These give us the apparent length of the feeder, and are accurate enough for the purpose of calculating the "loss" or "drop" and the size of wire. For the purpose of estimating the cost of the feeder, however, it is not sufficient. To get the actual length of the feeder we must try to conceive the exact course or route of the feeder, taking into consideration all deviating bends, off-sets, etc., making allowances or going around or under any obstructions, and also for connecting at each end of the wire. Even after having done this, experience shows that it is necessary to add about 5 per cent for slack, etc., to the estimated length thus obtained, in order to get the real length. If the building is already built, it is much the better plan to get these lengths directly from the building.

Next comes the question of the distribution of the "loss" or "drop" in voltage among the various conductors from the switchboard to the lamp. As this also was discussed in the last article, we will not again consider it.

Having determined on the loss to be allowed in the feeder, we have the three necessary factors for determining the size of wire required for the feeders and mains. These factors are the current in amperes (or the number of lamps), the length in feet (one way), and the loss (in volts) to be allowed. In the third article of this series we deduced the formula for determining the size of wire when these factors were given. The formula is

$$CM = \frac{L \times O \times 10.14}{E}$$

where CM = area in c.m. (size of wire), D = length of circuit (one way), L = number of lamps and E = the loss in volts.

Before calculating the size of the feeders, however, it is well to get the data necessary for calculating the size of mains. This is done in a similar manner to that referred to above in getting the data for the feeders. A preliminary arrangement of the mains has presumably already been made, and the calculation of the feeder and the mains should be made conjunctively, so that if it be found desirable, the loss that was allowed for the feeder may be increased and the loss allowed for the mains correspondingly decreased, or vice versa. It will frequently be found that a new arrangement of the mains will give better results as to size or loss than the original arrangement.

Figs. 1 to 5, inclusive, show arrangements of mains where there is a feeder for each floor and where there are several distributing centers on the floor, all of which are supplied from the feeder center by means of mains. Each of these figures, of course, shows but one floor.

Fig. 1 is an example where the feeder center is located in about the center of the building and supplies two distributing centers on each side of it. This arrangement of mains is ideal. The fuses at the origin of the mains are all located at one point (the feeder center), which simplifies matters when one of the main fuses blows, it being easier to discover the location of that particular fuse if it be known that all the main fuses on the floor are located in one cabinet. This arrangement also gives a uniform potential at each of the four distributing centers. Furthermore, where there is a considerable number of lamps supplied at the various centers, it keeps the mains, and consequently the conduits, down to those sizes which can be readily installed in the available space between the beams and the finished floor. Where, however, there are only a few lamps supplied at each center, it has the disadvantage of being slightly more expensive than the arrangement shown in Fig. 2. This is a very fair arrangement, and is the one generally adopted where the loads on the mains are light. What disadvantages it has are obvious when compared with the arrangement shown in Fig. 1.

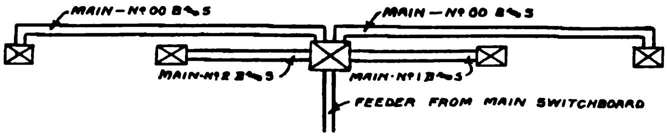


FIG. 1.—LAY-OUT ON ONE FLOOR.

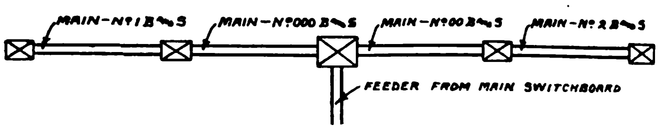


FIG. 2.—LAY-OUT ON ONE FLOOR.

Figs. 3, 4 and 5 show arrangements of mains where the feeder distributing center is located at one end of the building, the other centers being all located on one side of it. Fig. 3 shows a very poor arrangement of mains. Its disadvantage is that, owing to the rule of the Fire Underwriters, it is necessary to place a "fuse at every point where a change is made in the size of the wire (unless the cut-out in the larger wire will protect the smaller)," and consequently to place a number of fuses in "series," located at different points. This always causes delay and confusion in time of "trouble." It is well to keep the number of fuses in "series" down to the lowest possible point, and also to centralize them as far as possible. This arrangement also has the disadvantage of making it difficult to get a uniform distribution of potential at all the distributing centers. Its sole apparent advantage is that of economy.

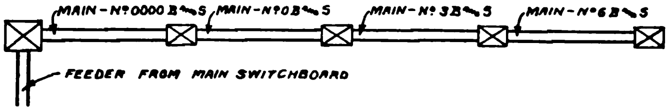


FIG. 3.—LAY-OUT ON ONE FLOOR.

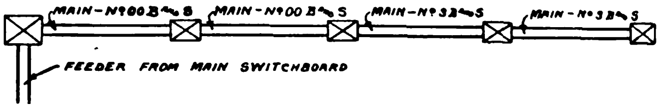


FIG. 4.=LAY-OUT ON ONE FLOOR.

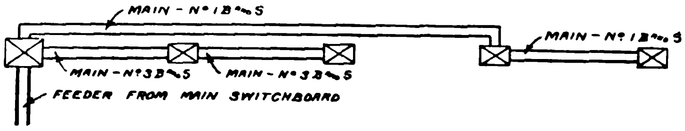


FIG. 5.—LAY-OUT ON ONE FLOOR.

Fig. 4 shows a similar arrangement to that of Fig. 3, but slightly better in that we have only two different sizes of main wires and have, therefore, diminished the number of fuses on the mains just one-half. This method is slightly more expensive, but for the reason given is undoubtedly preferable to the former.

The writer heard recently of a case where a multiplicity of fuses caused considerable annoyance. It happened in an office building, where one floor of the building was rented for a purpose not originally contemplated; some additional wiring and fixtures were installed, making the load considerably beyond that originally carried by the feeder and the mains, but not, however, beyond their safe carrying capacity. The fuses happened to be considerably below the carrying capacity of the wire; when the lights were turned on (at the time, of course, when they were most needed), one of the branch circuit fuses supplying two arc lamps immediately blew. This fuse was replaced and the lamps again turned on. This time a number of lights went out, including the two arc lamps. The branch circuit fuses were found to be all right, but a main fuse had blown. This was replaced, the lamps turned on, and the lights went out again. This time it took a longer time to find what fuse had blown, as the attendant happened to be unfamiliar with the arrangement of the mains and cut-outs, but finally it was found that the fuse on a main of which the main above mentioned was a prolongation, this fuse being located at another distributing center, had blown. This was replaced, and then the feeder fuse blew. It happened that the two arc lamps, in starting, took about 20 amperes, and this was sufficient to blow each fuse successively. The arrangement of the mains and the fuses in this case was unavoidable, but it shows the necessity of reducing the number of fuses in series to the lowest point possible.

Fig. 5 shows an arrangement of mains which is preferable to the arrangement shown in either Fig. 3 or in Fig. 4.

The next case to consider is that where a feeder is not limited to supplying one floor only, but may supply two or more floors. This gives more scope for the arrangement of the feeders and the mains. In such instances there may be several rising places for the feeders; in fact, if suitable rising shafts could be found, a good arrangement would be to have the distributing centers placed near these rising shafts at each floor, with a set of feeders rising at each one of the shafts and feeding several floors at each point by means of vertical mains. Where it is not necessary to control each floor separately, this generally makes the cheapest and best arrangement.

Figs. 6 to 9, inclusive, show different arrangements of feeders and mains of this type (i. e., where a feeder may supply more than one floor). Their relative advantages and disadvantages are evident from what has been already said in regard to the arrangements shown of the first type (see Figs. 1 to 5). Figs. 6 and 7 are examples of cases where there are no horizontal mains at all. This is a good fea-

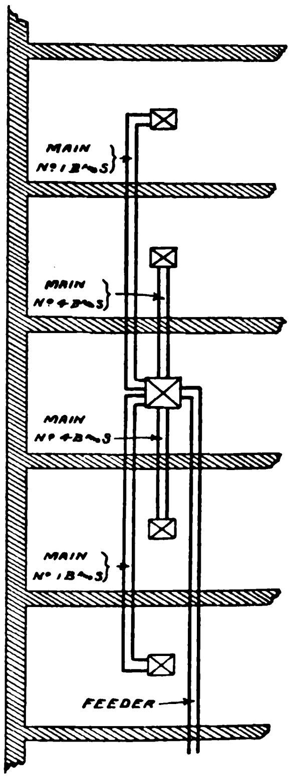


FIG. 6.—VERTICAL MAINS.

ture, particularly where the mains are large, as it keeps large sizes of conduits off the floor. It is nearly always easier to find room vertically for large sizes of conduits than it is to find room for them between the beams and the finished floor. The data for feeders and mains of this type is, of course, procured in a manner exactly similar to that adopted in the previous case.

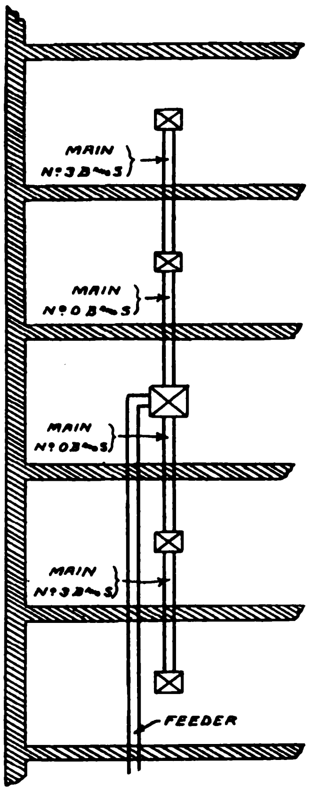


FIG. 7.—VERTICAL MAINS.

The only remaining case to be considered is that in which separate feeders are required for the hall or public lights. What has been said above in regard to the feeding systems in general will also apply, with slight modification, to the hall feeders. The hall feeders, however, usually have much lighter loads, and consequently are smaller in size. It is very rarely necessary or desirable to have a separate feeder for the hall lights on each floor, but one feeder can easily supply the hall lights on several floors. In fact, usually the only limit to the number of floors that may be supplied by one feeder is the refinement of control desired from the main switchboard.

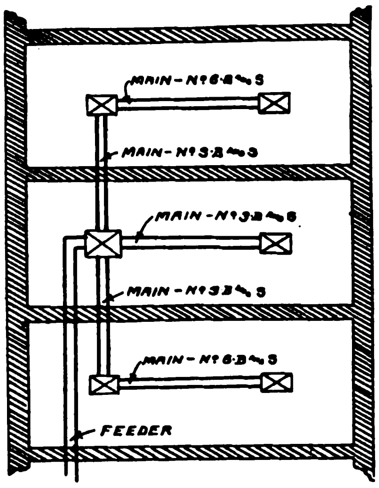


FIG. 8.—COMBINATION MAINS.

We have already mentioned that it is sometimes wise to have two sets of feeders for the hall lights, one set controlling a portion of the hall lights on each floor, the other set controlling the remainder. The character and use of the building and the number of public lights required usually serve as guides for determining or not if this provision is necessary. Of couse, in procuring the data for the feeder and mains of this type the number of hall lights is kept separate from the room lights. Several of the diagrams in the previous article show arrangements of hall feeders.

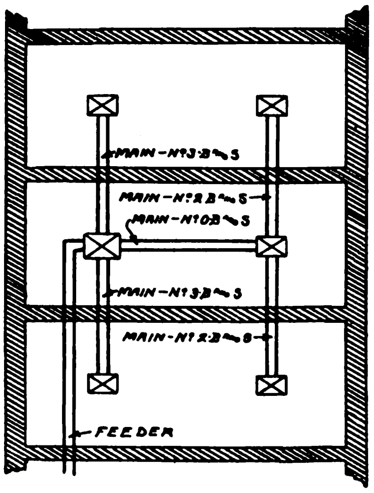


FIG. 9.—COMBINATION MAINS.

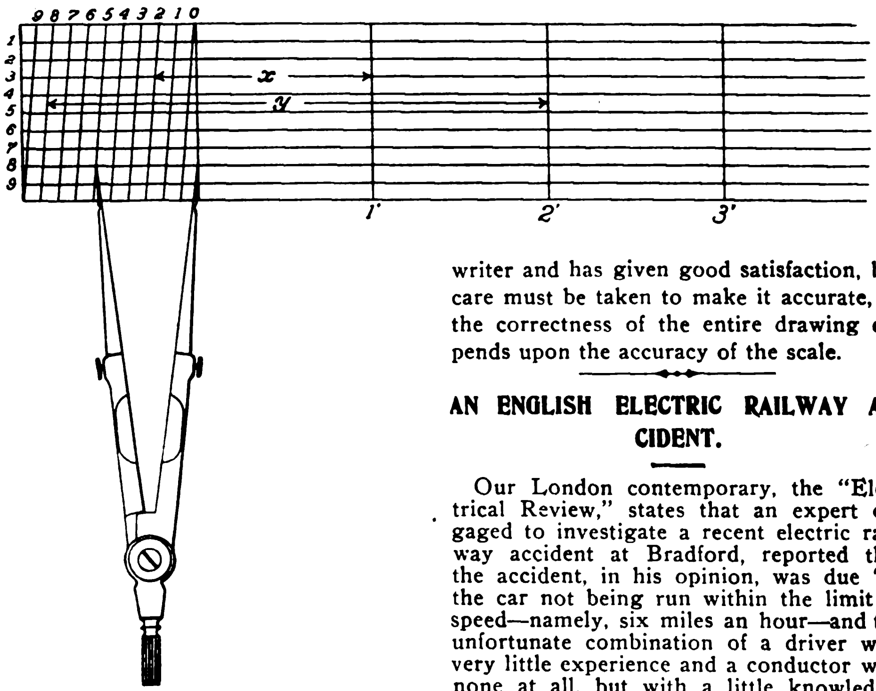
THE DECIMAL DIAGONAL SCALE.

BY ROBERT W. BOARDMAN.

The draughtsman or student is often called upon to make drawings involving the use of measurements to a hundredth or thousandth part of an inch, and as such a scale may not always be at hand, it is the purpose to show here how to construct one in a very short time that will answer the purpose satisfactorily. Construct the scale as shown in the figure by drawing eleven horizontal lines 1-10 of an inch apart; then divide the scale into inches by the vertical lines 0, 1', 2', 3', etc. The division upon the left has the upper and lower lines sub-divided into tenths of an inch. which are then joined by diagonal lines running from each upper tenth to the next consecutive lower tenth.

As each diagonal traverses the ten equal spaces it advances 1-10 of an inch; hence, for one space it advances 1-100 of an inch, and by glancing at the numbers at the side of any particular horizontal line, we have the hundredths in addition to the tenths marked on the top. For example, the dividers are set to read 58-100 of an inch, which is found by glancing along the top and finding that the point of the dividers rests on the fifth line, which gives us $\frac{5}{10}$ in.; then looking at the side we find that it also rests on the eighth horizontal line, which gives us $\frac{8}{100}$ in.; hence, $\frac{5}{10} + \frac{8}{100} = \frac{58}{100}$ of an inch. Distance x in a similar way equals 1 23-100 of an inch, and the distance, y, equals 2.845 in. From the latter it may be seen that by taking measurements between the horizontal lines, distances can be laid off which are correct to a thousandth part of an inch.

The scale has been frequently used by the writer and has given good satisfaction, but care must be taken to make it accurate, as the correctness of the entire drawing depends upon the accuracy of the scale.



DECIMAL DIAGONAL SCALE.

◆

AN ENGLISH ELECTRIC RAILWAY ACCIDENT.

Our London contemporary, the "Electrical Review," states that an expert engaged to investigate a recent electric railway accident at Bradford, reported that the accident, in his opinion, was due "to the car not being run within the limit of speed—namely, six miles an hour—and the unfortunate combination of a driver with very little experience and a conductor with none at all, but with a little knowledge, which is proverbially a dangerous thing, a slippery road, and extra pressure on traffic due to Barnum's Show. The driver used the brake-power in an injudicious manner, but the conductor put on the hand brake, and thus deprived the driver of full control of the brake power. He also caused the trolley to be disconnected, thus depriving the driver of the power of reversing, which might have prevented the accident!" The expert considers that the brake-power was ample, and that by means of the graduation of the electric brake the speed can be regulated with ease and certainty provided that six miles an hour is not exceeded. He approves the addition of a slipper brake.

STEAM ENGINE PISTONS.—II.

BY JAMES F. HOBART, M. E.

It was found by early engine builders, that unless the piston swept over the end of the cylinder bore there would be a bad ridge left when the piston terminated its stroke. To permit the piston to sweep into the counter bore, and still reduce clearance to a minimum, and at the same time secure sufficient strength of piston, the latter was made thicker at the middle and chamfered off at the edge, so as not to cover the steam part when the piston is at the end of the stroke. Some engine builders cut a short chamfer in the edge of the piston, and, as described in the November issue, the piston sometimes revolved in the cylinder until the part was covered.

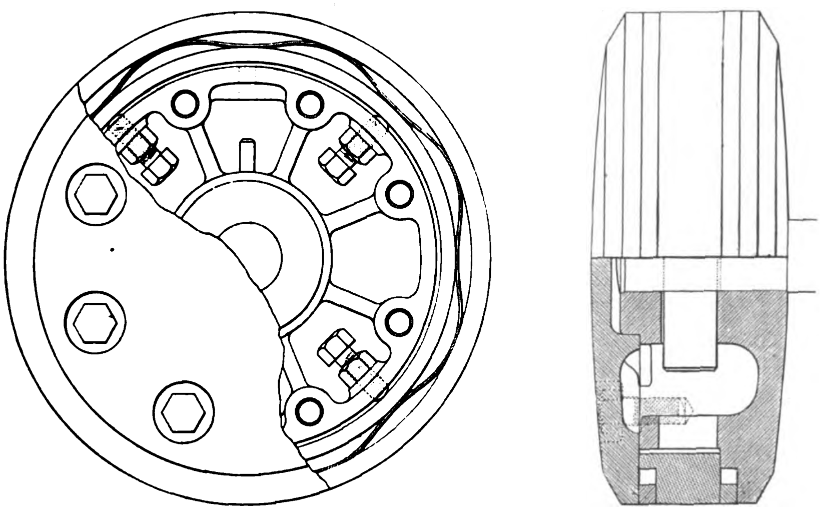


FIG. 1.—CHAMFERED PISTON SPRING PACKING, KEYED ROD.

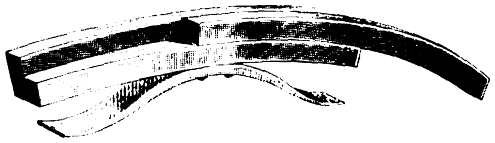


FIG. 3.—SECTION OF PACKING RINGS.

The piston shown by Fig. 1 is free from this defect, as it is chamfered all around, and it makes no difference in what position it is placed in the cylinder. The weight is carried on a central ring, which is adjustable in the usual manner, two packing rings are used, and they are both steam and spring adjusted.

The center ring is given a peculiar shape, the usual custom being to turn this ring somewhat smaller than the bore of the cylinder. In this, however, that portion of the ring which rests on the cylinder is turned to fit. The upper portion of the ring is then turned off, giving the desired clearance. The ring is, therefore, turned "out of round" or on two separate and distinct centers. Full bearing surface below and clearance above are thus secured from the start.

The two packing rings are turned a little smaller than the bore of the cylinder, cut apart and halved together at the joints. Thus they keep in easy contact with the cylinder when in place, but are supplemented by light springs which keep them in contact with the cylinder until worn out. It is claimed that this piston needs no attention whatever, except to center it about every six months.

Some pistons are made of very complex form, especially the packing thereof. The one shown by Figs. 2 and 3 an example.

In this piston double rings are used. Each complete ring is formed of several segments overlapping, as shown in cut, in order to insure steam tight joints. This may be known as sectional packing. This type of packing ring is very satisfactory in pistons of large engines. The section of piston shown at the lower portion of cut shows method of cutting up the double rings, also attaching small springs thereto. The springs are of the very best steel with spring temper, and it is claimed that the sectional packing sets so closely against the cylinder that there is no leakage of steam and no excessive pressure.

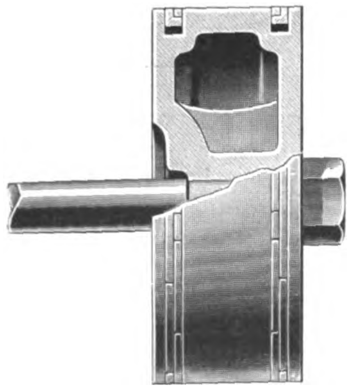


FIG. 2.—SECTIONAL PACKING.

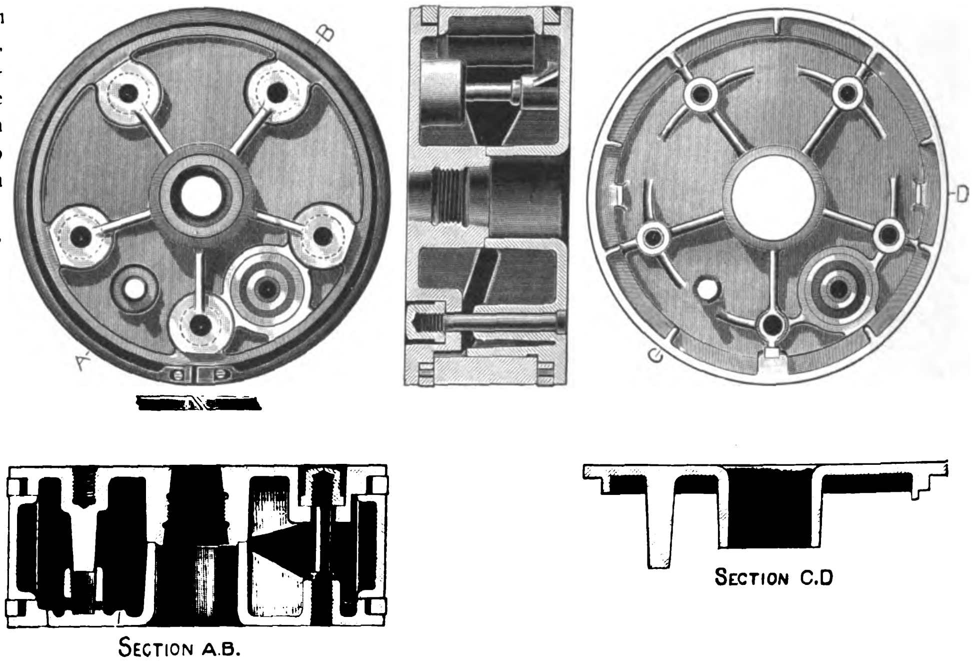


FIG. 4.—"POP PISTON."

Probably no more novel piston exists than the one illustrated by Fig. 4. Here there is a central ring which is independent of the packing rings, and is free to move separately from them. The rings, however, are made fast to the piston itself in a very novel manner. The rings are made much too large for the cylinder, sprung in with considerable force and pinned by dowels passing lengthwise with the piston rod, into the follower and the body of the piston.

Then the rings are turned off to fit the cylinder and the holes in the rings are filed a little so as to allow the rings "limited expansion," from which they take that name.

It is claimed that these rings do not leak, or cut the cylinder, and they run easier than pistons having their rings forced against the surface of the cylinder.

The "pop" feature of this piston is to take care of more water in the cylinder than can be contained in the clearance. To this end a plug of considerable diameter is fitted into each end or side of the piston, under a pressure of 200 lbs. to the square inch. On this pressure will start the plugs and drive them into the space inside the piston.

In case of more water than the clearance can take care of, and this may happen at any time, or never, one of the plugs is driven in by the pressure, which might break the engine if not relieved, the cavity inside the piston is then, by the driving in of the plug, added to the clearance space of the engine and takes care of the water until it can be driven off through the exhaust.

The action above described does not call for an immediate stopping of the engine to replace the plug, for the machine can run indefinitely with only the loss due to the increased clearance. The plugs can be replaced by the engineer, and a device gives notice when they are driven out.

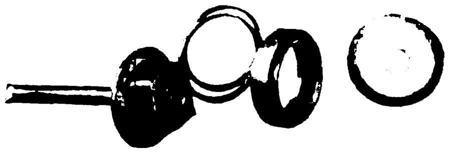


FIG. 5.—PISTON FOR SMALL ENGINES.

An excellent form of piston, having separate adjustable bull ring and follower bolted on, is shown in Fig. 5 for small engines, and Fig. 6, for large engines. The half-tones show the construction well—for which there is claimed great strength and rigidity with light weight, and consequently very little friction and wear, and no leakage.

The piston rods are pressed in by hydraulic pressure and the rods riveted in the smallest sizes; in the larger sizes the pistons are pressed on the rods and then secured by a steel nut. The pistons and rods are finished together after assembling in every case, insuring good and true work.

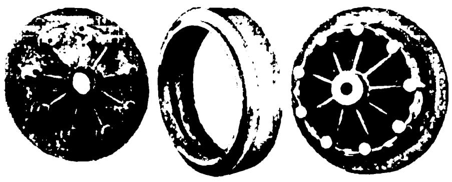


FIG 6.—PISTON FOR LARGE ENGINES.

The pistons used in gas engines are entitled to a word in this connection. They are nearly all of the trunk form, or a modification thereof, and the one shown by Fig. 7, although used also in a steam engine, is a fair sample. This piston carries two snap rings, and in some cases they are made of German silver. That metal is a favorite for steam packing adjustment rings, for the reason that it does not corrode under the trying conditions in which it is used. This piston carries the crosshead pin of the engine, but there is no adjustment there. In fact, there is no need of it in any single acting piston, for the pressure is always in one direction, hence there is no pounding in the crosshead connection.

In some gas engines the crosshead pins are of steel, one-fourth the diameter of the piston, but are made hollow for lightness and are held in place by easily reached adjustable bearings. In one variety of gas engine four cast-iron snap rings are used. In another form are sectional rings set out by German silver springs, which enable the rings to be used until entirely worn out.

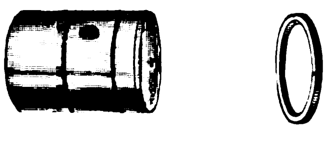


FIG. 7.—SINGLE ACTING PISTON.

ECONOMIC STEAM PRODUCTION.

Economy in the application of steam has been a subject of thorough and intelligent discussion and effort since the days of Watt, the result of which has given us the present excellence in engine design and construction. Doubtless many minor improvements will yet be made, especially in electrical and other secondary apparatus for the application of steam energy to the various commercial uses; but this field in general has been and is being thoroughly exploited.

Steam production, however, as a separate subject, has not received the attention its importance demands. What special attention it has received has come principally from manufacturers and others interested in the introduction of "improved" forms of boilers, heating systems, feed water heaters, economizers and kindred apparatus.

Since the production of steam is so apparently inseparably linked with the production of electricity, it is fitting that this subject be thoroughly and intelligently discussed, and thereby secured such attention to its details as will secure improved methods and appliances.

It is not the purpose of the writer to cover the field in one article, but rather to introduce the subject and follow it up in later issues with definite details, with the hope that other and more competent minds will be interested, thereby securing to the public much needed information relating to new developments and improvements, and including contrasts of different methods and the benefit of personal experiences.

To my mind there appears to be little probability of material improvement, except as to minor details, in boiler construction, but there is room for decided improvement in boiler room practice. There are comparatively few engineers, or even "steam experts," who give any special attention to steam production, except incidentally and as connected with the application or use of steam energy.

As an illustration in this line, about a year since, while visiting a lighting station in one of the cities of the central section of the country, I was shown through the plant by the courteous engineer in charge. While in the boiler room, noting a special form of boiler, with an "improved" furnace attached, I asked about the capacity that could be realized. (The boilers were of 300 h.p. capacity, as rated by the manufacturer.) The engineer replied: "We have taken 625 h.p. from that one on one occasion when in a pinch." I remarked, "You pushed it pretty hard." He replied: "Yes; but we had to do it. She stood it, though, all right, and carried our load for full three hours." A little later, while looking over the engines, he told me they had been tested only two or three days previously, and on my inquiring as to the quantity of water the engines took he said they found they were using 15.2 lbs. of water per i.h.p.

I said nothing to the engineer, but mentally calculated that the load that boiler carried required but little over one-half the h.p. indicated or delivered by the engine, and was therefore, at the time the engineer referred to, when boasting of its wonderful achievement, evaporating not to exceed 320 boiler h.p., or less than 7 per cent above the rated capacity. The engineer was, when talking about the boiler, referring to engine h.p. delivered instead of to the h.p. delivered by the boiler.

That engineer did what a large majority of his profession, and not a few consulting engineers, are constantly doing—made no distinction between boiler h.p. and engine h.p. He had no intelligent conception of steam production as distinguished from steam consumption, and was therefore badly mixed in his account of the performance of his boilers.

The reader will readily see how such confused ideas of conditions and results hinder, when they do not altogether prevent, intelligent practice and improvement. How is a man with such confused ideas to judge intelligently of the utility or value of an "improved" form or make of boiler or furnace or other appliance connected with the steam producing part of a plant?

This incident, while it relates alone to the boiler and furnace, will serve to indicate the necessity for distinct and exact information as to the details of the production of steam, as distinguished from its application. In the next issue I hope to be able to call attention to some of the many details in relation to which increased knowledge and improved practice will result in increased economy.

Lessons in Practical Electricity

HOW TO DESIGN A DYNAMO.

Continuing the calculations of the last section it is to be noted that the armature must be divided into two parts, the teeth and the core proper, for the teeth are fluxed at a different density from that which occurs in the core. The teeth are wedge shape and their average width will be found to be .209 inches. This quantity we multiply by the length of the armature and by the number of teeth a pole subtends, which gives us 32.19, the area of the magnetic path in the teeth. The length is equal to twice the length of the teeth because there are two paths, one on either side of the armature. To find the permeability we must refer to a curve of the magnetization of wrought iron. This curve is shown in Fig. 2, and it may be added that wrought iron is very uniform in its magnetic qualities and almost any permeability curve for wrought iron will do. We have a total flux of 3,095,240 lines passing through 32.19 square inches, a density of 96,000 lines per square inch. From the curve we find the permeability at this density to be 580, and from the formula as shown below we obtain ampere turns necessary to force 2619046 lines through the teeth.

$$\text{amp. turns} = \frac{2 \times .6958 \times 2619046 \times .3132}{32.19 \times 580} = 61$$

The armature itself is an easy calculation. The length of the path must be taken from the drawing of the disc by measuring the length of a line through the path of least reluctance, as shown in Fig. 4. Its area is equal to the armature length multiplied by the thickness of the ring, less the depth of one of the slots. As there are two paths from pole piece to pole piece through the armature of equal length, this area must be doubled. Its permeability from the curve is 1350, and the necessary ampere turns calculated from this data is 103.

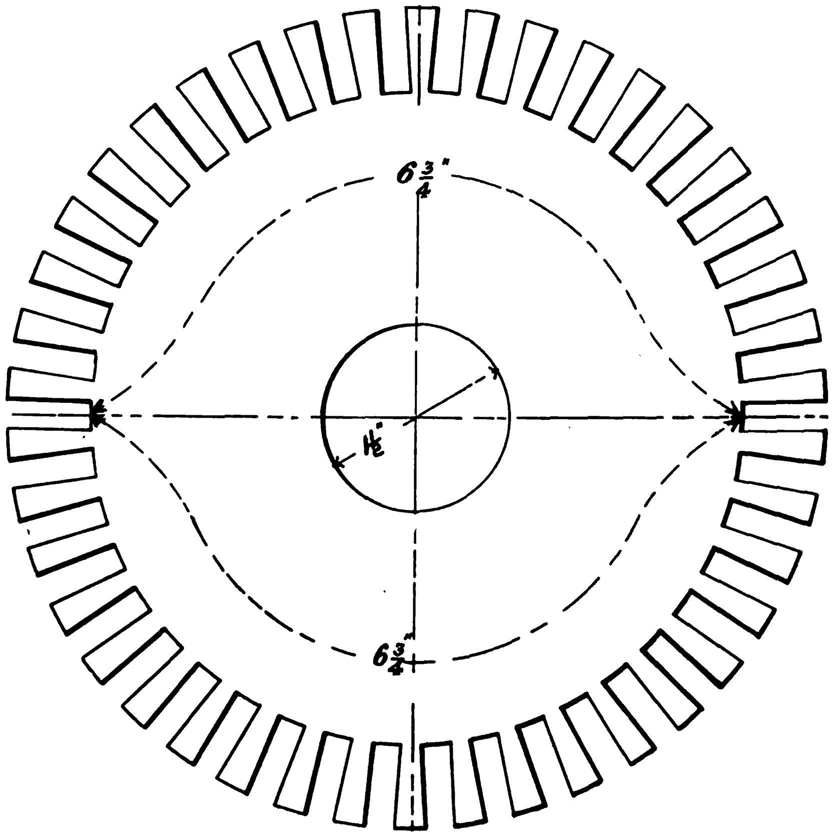


FIG 4.—MAGNETIC PATH THROUGH ARMATURE FROM POLE TO POLE.

We may now summarize the following data:

Ampere turns necessary to force 4,190,474 lines through the field magnets. . . . . =	726
Ampere turns necessary to force 2,619,076 lines throught the gap space. . . . . =	1410
Ampere turns necessary to force 2,619,076 lines through the teeth =	61
Ampere turns necessary to force 2,619,046 lines through the armature core. . . . . =	103
Total ampere turns for shunt coil. . . . . =	2300

Comparing this value with 3792, the ampere turns we estimated, we find that when we have calculated the series coil we shall approach this value and shall have ample room on the field frame as it is.

The shunt bobbin must therefore furnish 2300 ampere turns. We will find the length of a single turn to be 37 ins., and, as previously explained, its resistance must be 125 divided by 2300, 125 being the voltage of the dynamo at the full load. Its resistance per foot is .01765, and the most suitable wire is No. 22 Birmingham gage. It will be noted that the wire chosen is somewhat larger than the actual wire that the formula dictates, for the reason that it is always well to have a margin, for it may be necessary to drive the dynamo a few revolutions slower than the rated speed, or it may be that the permeability of the field magnet is not what curves or experiments have predicted it to be, and furthermore, the conductivity of the wire may be somewhat less than that of pure copper. If the machine should have a slight excess of voltage, that can be taken care of by the rheostat. The object of the calculation is that this excess shall not be so great that it shall cause a large amount of power to be consumed in the rheostat.

On the field magnet we have designed we can allow a space 1¼ ins. deep and 3½ ins. long on which to wind the coil, and on such bobbin we can wind 2726 turns, and as we have two such bobbins we shall have 5452 turns in all. The ampere turns are 2300, from which we may calculate the amperes at .44, and the watts consumed to be 55. The square inches of surface which these bobbins afford for radiation is equal on their sides to 302 square inches. On the ends the actual radiation surface is, of course, 206 ins., but it may be assumed to also include the hole in the center of the bobbin because that is filled by a mass of metal which is capable of conducting away much heat. The total radiating surface may therefore consist of sides 302, ends 430, total 732 ins. The square inches per watt are 13, which is a very large allowance. The bobbin will not even become warm. The temperature that it will attain over and above the surrounding air may be calculated by multiplying the watts by 100 and dividing by the square inches, giving in this case 7.5 degs. F., a figure so low that it is extremely probable that the manufacturer would prefer to shorten his field magnet and wind on less wire, thereby economizing both copper and steel and not greatly affecting the efficiency of the machine. It is probable that the shunt wire could be reduced one-half without involving a serious rise in temperature. This would divide the copper by two and reduce the length of the magnetic circuit nearly 3 ins., and though the field excitation would be increased to about 100 watts, it would still be within 2 per cent of the total output of the machine, and such a change would be advisable. It would be difficult to build such a machine within efficiency much exceeding 85 per cent, and therefore a slight saving of 1 per cent is not worth this extra expenditure of iron and copper. The methods of recalculating are the same as those which have already been shown and need not be discussed further. We shall therefore continue the calculation of the series coil with the field magnet as it is, for to follow the recalculation through its various phases would simply involve arithmetical repetition without imparting any new principles.

◆

Letters on Practical Subjects

Transforming Direct and Alternating Current Motors.

To the Editor of American Electrician:

In a recent number, F. B. D. asks if he can modify a ¼-h.p. direct current motor to furnish an alternating current, presumably single-phase, of 7200 alternations per minute. Having performed a similar experiment some time ago, I would suggest that "F. B. D." will find this a very easy matter, as there is no rewinding necessary.

Simply slip a pair of collecting rings over the commutator, "tapping" these in on diametrically opposite segments, but keeping them insulated from each other and the remaining commutator bars.

Assuming that he has a bipolar machine, it will now be necessary to raise its speed to 3600 r.p.m.—a speed quite safe in so small a machine, provided it is well balanced.

This increase in speed is most easily accomplished, in a shunt motor, by inserting in series with the field an adjustable resistance.

Having adjusted the speed to the desired value by this means, an alternating current of about 2 amperes, at a pressure of about 77 volts, and a periodicity of 7200 alternations, can be drawn from the rings. This would be the maximum output of the machine.

In the same number "T. L. D." asks if he can run a 125-cycle fan on a 60-cycle circuit.

If the motor is of the induction type and has multipolar field of eight poles, its normal speed on the 125 circuit will be about 1800 r.p.m.; while if placed on the 60-cycle circuit, its speed will be only about 900 r.p.m., and it will take more than its normal current, due to decreased reactance on the lower frequency.

Now, by simply reversing the terminals of four of the field coils the poles are reduced to four and the motor will now run at 1800 r.p.m. on the 60 circuit. This makes the speed right, and can be done by starting anywhere on the field ring, reversing two coils in succession, then skipping two and reversing the next two.

If the current is still too much, it can be reduced by inserting a reactance coil. Of course, if the motor has but six poles the above plan of reducing the poles is not applicable.

J. C. BROWN.

New York, N. Y.

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Connecting Transformers.

To the Editor of American Electrician:

Sir—I have two transformers for 1100 volts each, and I desired to connect them to a 2200-volt circuit. They were not provided with double coils whereby the voltage might be raised by reconnecting them. I decided to connect the primaries in series across the mains. I found that as soon as I loaded one of the secondaries the results were satisfactory, if only a few lamps were put on, but as more lamps were put on the voltage fell, and this occurred before the transformer was loaded to anywhere near its capacity. It then occurred to me to load the other transformer, which I did, and found that as I increased the load the brilliancy of the lamps on the first transformer rose, and that the best results were obtained when the current in both transformer secondaries was equal. I then connected the secondaries in multiple with each other, and found that I could load the circuit thus provided with the combined capacity of both transformers with just as good results as if the primaries were fed from a 1100-volt circuit.

J. R. KEATOR.

Pittsburg, Pa.

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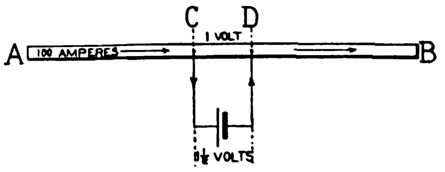
An Electrical Paradox.

A letter by Mr. C. D. Blake, entitled "An Electrical Paradox," which appeared last month in this department, has brought a large number of communications, a selection from which, and of various degrees of merit, are printed below. In order to render the references of the writers clear, the letter which led to the discusion is reprinted immediately following:

To the Editor of American Electrician:

Sir: From the accompanying diagram some very ludicrous conclusions may be drawn on apparently logical grounds. AB represents a feeder of, say, an electric railway system, carrying 1000 amperes. The little distance DC represents a length of this feeder in which the drop of potential is 1 volt. If we apply an e.m.f. of 1½ volts to these terminals, opposed in direction to the direction of the current, we shall reverse the latter, stopping the main current altogether, because it is presumably impossible to have two currents flowing in opposite directions in the same wire. If this is true for the position shown, we can reduce the distance CD to a smaller amount and apply a lesser voltage and the same result will still hold. If all this is true, we can take any battery, however small, and similarly connect in a short section of a feeder carrying a powerful current and stop the latter altogether.



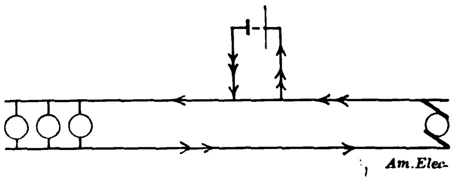
The much mooted question of current in the Brooklyn Bridge cables could thus be very easily solved by the proper application of a few cells of dry battery. The conclusion savors so much of the impossible that, in spite of the apparently logical premises, it cannot be credited; and it has been my experience that the would-be solvers of this problem are either compelled to make astonishing assumptions or quickly argue themselves into difficulties in endeavoring to evade the issue. I submit it on its merits to your readers.

C. D. BLAKE.

New York, N. Y.

To the Editor of American Electrician:

The "Electrical Paradox," as referred to by Mr. Blake in the November number of the "American Electrician," is explained by a glance at the accompanying diagram.



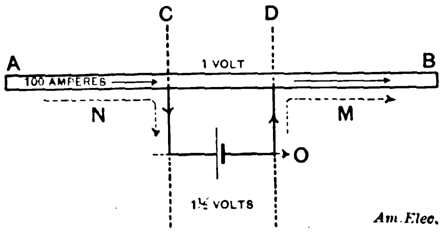
The battery current, instead of flowing in the opposite direction to the current in the feeder, completes its circuit by flowing with the current in feeder through the load, generator and back to battery.

O. H. HUTCHINGS.

Dayton, Ohio.

To the Editor of American Electrician:

Gentlemen: In reference to the letter of C. D. Blake in issue of November, 1898,



I would say that if an e.m.f. of 1½ volts is applied to the terminals CD, opposed to the direction of flow of current in conductor AB, the flow of current in AB is neither stopped nor reversed, but the action of the battery of 1½ volts is to form a better path for the current in the main conductor, and the battery current will assist the flow of main current in the direction of NOM.

T. W. VARLEY.

New York.

To the Editor of American Electrician:

Referring to Mr. Blake's electrical paradox in the current number of the "Electrician," it appears to me that the only thing that would happen would be to increase the fall of potential between the points indicated. In the case that he mentions, instead of there being a fall of 1 volt in a given length of wire by the connecting up of a battery having a voltage of 1½ volts to that length, it would simply increase the fall to 2½ volts. If at a certain point there should be 500 volts and 499 a foot further on, the 1½-volt battery would be struggling against that force and not against the 1-volt drop. Yours truly,

CHARLES HARDING.

Cincinnati, O.

To the Editor American Electrician:

As to the "Electrical Paradox" of Mr. Blake, it seems to me that the confusion arises from a misunderstanding of the method of determining the total e.m.f. As I understand his statement, the drop in potential between C and D is 1 volt; now, by opposing 1½ volts he would merely reduce the applied e.m.f. 1½ volts, as this voltage would act in opposition to the applied e.m.f. and with the drop in potential. That is, the voltage at D would be the voltage at C, minus the drop in potential and minus the 1½ volts. Putting the 1½ volts in opposition to the e.m.f. at C would have the same effect as introducing a resistance which would cause a drop in potential of 1½ volts.

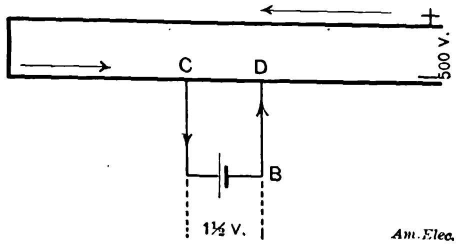
If a dynamo, having the same resistance as CD, were placed between C and D and made to generate electricity at a pressure of 1½ volts and in an opposite direction to that of the applied e.m.f., then our conditions would be similar to those given by Mr. Blake. The dynamo would cause a pressure of 1½ volts between C and D, but this would not stop the current, but would merely make a decrease of 1½ volts in the applied e.m.f.

HORACE SHRADER.

New Orleans, La.

To the Editor of American Electrician:

Referring to the letter of Mr. Blake in your November issue, suppose in the accompanying diagram the total resistance of



the circuit is 5 ohms, and the total current 100 amperes. If CD has 1-100 ohm resistance, it would have a drop in it of 1 volt, that is a counter e.m.f. of 1 volt. That part of circuit shown with heavy lines, and which carries, say, 100 amperes, we will call circuit A. Now, at CD insert a battery of

1½ volts (and call it circuit B), so that its e.m.f. will be in opposition to that of the larger circuit A. Then this 1½ volts will act as counter e.m.f., in CD to current in A, and must be added to the counter e.m.f. produced by the 1-100 ohm resistance of CD, making 2½ volts counter e.m.f. This produces the same result in circuit A as if CD had a resistance of 2½-100 ohms.

Consequently there is no reason for the flow of current from the battery in B through CD stopping or changing the direction of the current in circuit A. All that will be done will be to change the amount of current. Taking the special case above:

$$\frac{\text{500 volts.}}{\text{50 ohms.}} = \text{100 amperes; then adding in the}$$

$$\text{drop caused by battery B, } \frac{\text{500 volts.}}{\text{5.015 ohms.}} =$$

99.709 amperes current.

One might as well try to stop a river's flow by throwing up a 1-ft. dam, on the ground that its fall is ½ ft. in the distance equal to the width of the dam, and that the water would not flow up stream 1 ft. to get over the dam.

S. T. Foster, Jr.

Laredo, Texas.

To the Editor of American Electrician:

The apparent paradox described in the November "American Electrician" is really very easily explained. It can mystify only those of your readers who have failed to thoroughly grasp the distinction in meaning between electromotive force and "difference of potential."

If we take a short section of the feeder referred to by Mr. Blake—a section of, say 15-1000 ohm resistance—it is perfectly true that the current produced by an impressed e.m.f. of 1½ volts will be 100 amperes. It is also true that if this current were to be opposed to the main current the latter would be neutralized. The error lies in supposing that a battery of 1½ volts e.m.f. is necessarily going to maintain a difference of potential of 1½ volts at the terminals of any external resistance to which it may be applied. A large induction coil may generate an e.m.f. of a million volts, but this does not mean that it will send a million-ampere current through a wire of 1 ohm resistance.

But to return to the paradox. Let us assume that we have a dry cell of 1½ volts e.m.f. and ½ ohm internal resistance —which is a low estimate. When we connect this cell to the section of feeder (resistance 15-1000 ohm), we will find that its terminal potential difference has dropped to about 44-1000 volt. If we decrease the length of section and, consequently, its resistance, our potential difference will decrease in a like ratio; until finally, when the resistance of the section becomes zero, the difference of potential at the battery terminals will also be zero, and the current flowing in the battery will be at its maximum. This current is found by dividing the e.m.f. by the internal resistance of the cell; and in the above case it would be exactly 3 amperes.

In short, to maintain a potential difference of 1½ volts under the conditions set forth in the paradox, we would require a battery capable of continuously delivering a current of 100 amperes at that pressure. It is evident that "any battery, however small" might experience some difficulty in meeting this requirement.

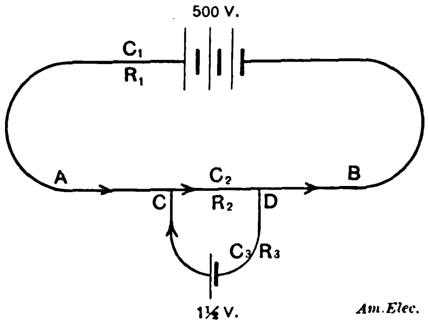
W. B. Hale.

Chicago, Ill.

To the Editor of American Electrician:

Sir: When one comes to look closely into Mr. C. D. Blake's "Electrical Paradox," appearing in the November number of your paper, the apparent absurdities vanish. It is simply a case of derived circuits containing two e.m.fs., and it may be solved by the methods usually applied to similar problems.

Since the e.m.f. of the cell is greater than the p.d. between the points C and D, in Mr. Blake's diagram, the current in the cell will flow in the direction of its e.m.f., and will utilize as part of its circuit the section of the feeder CD, increasing the current in the latter. The increased current produces an increased p.d. between C and D which virtually increases the resistance of CD, as regards the rest of the feeder circuit, and therefore decreases the current in this latter part of the feeder; but the decrease is so small that if Brooklyn Bridge depended for its safety upon the method of protection suggested by Mr. Blake it would be doomed to destruction.



In support of the above, I offer the following proof: In the enclosed diagram, which is the same as Mr. Blake's, except that the feeder circuit is drawn complete, let C_1 be the current in any section of the feeder other than CD; let C_2 be the current in CD, and let C_3 be the current flowing through the cell; further, let R_1, R_2 and R_3 be the resistances of these different parts of the circuit. Then, assuming that the feeder e.m.f. is 500 volts, and applying Kirchhoff's laws:

$$C_2 = C_1 + C_3,$$
$$C_1 R_1 + C_2 R_2 = 500$$
$$\text{and } C_1 R_1 - C_3 R_3 = 500 - 1.5.$$

Now, according to the conditions of the problem, before the cell is connected to the feeder,

$$R_2 = \frac{1}{1000} = .001 \text{ ohm.}$$

$$R_1 = \frac{500}{1000} - \frac{1}{1000} = .499 \text{ ohm.}$$

and let $R_3 = .3$ ohm.

Substituting these known values in the above equations, and solving, the following is obtained:

$$C_1 = 999.99667 \text{ amp.}$$
$$C_2 = 1001.66167 \text{ amp.}$$
$$\text{and } C_3 = 1.665 \text{ amp.}$$

The analogy between the electric current and the flow of water in pipes, so often used, may be very happily applied in this instance.

André J. Picolet.

Philadelphia, Pa.

To the Editor of American Electrician:

The communication under this heading in the November issue is of sufficient interest to warrant careful consideration, although it is difficult to conceive how any one other than the talented scientific reporter to some great Sunday New York newspaper can be misled by the argument offered.

Mr. Blake considers the case of a power feeder carrying 1000 amperes and takes a short section of it, between the ends of which is a drop of 1 volt. He says if we apply an e.m.f. of 1½ volts to the terminals of this section, this applied e.m.f. being opposed in direction to that of the 1000 amperes current, we thereby reverse it and "stop the main current altogether."

Mr. Blake points out that if we take a still shorter section the drop, or voltage, between terminals will be correspondingly reduced, and he offers the conclusion that "we can take any battery, however small, and connect in this way with a sufficiently short section of a feeder carrying a powerful current and stop the latter altogether." Mr. Blake evidently does not believe this to be true; but he thinks it requires "astonishing assumptions" to clear up this seeming paradox. In reality, the "astonishing assumptions" have been made by Mr. Blake himself in jumping to his remarkable conclusion.

We are not warranted in assuming any conclusion of an argument directly on the strength of the truth of our premises, but every intermediate step must be in perfect logical sequence and therefore unquestionably true also.

Now, it is, of course, perfectly true that if we take any section of a wire carrying current and apply and maintain at the terminals of this section an e.m.f. equal to the drop due to the original current, but opposed to it in direction, we shall entirely stop the current in this section. (We assume here—and this in no way affects the general question, but merely saves unnecessary complication—that the drop in this section is so little, in comparison with the total voltage of the circuit, as not to appreciably affect the current.) It is not true, however, that a small battery will do for this purpose. In the case of a 1000-ampere current a very large storage battery would be required, and the connections would have to be very much larger than the original feeder, so as to have a much lower resistance.

In such a case, when the battery and connections were so adjusted that no current was passing in the section of feeder, the whole of the 1000-ampere current would pass through the battery instead. (In reality, the total live current would be slightly increased, but, as before stated, we need not now consider this.) If the battery voltage were slightly higher there would be a corresponding reversed current in the feeder section, and this additional current would be added to the 1000 amperes passing through the battery, but would not appear on the main line. When the current was just killed in the section, the latter might be cut without affecting the main line circuit.

Now, in practice these conditions could not be maintained. Imagine the feeder section so bent as to be directly connected to battery terminals. Then, to just kill the current in the section, our battery would have to be just able to give through itself 1000 amperes on dead short circuit. If the battery were any smaller than this, the current in the section would not all be killed, and if it were any larger a reverse current would flow. It is not worth while to consider how large a battery would be necessary, nor how long, or how short, rather, a time it would last.

In the case of Mr. Blake's small battery the voltage (say, 1½ volts) refers only to open circuit, for the external voltage of such a cell falls rapidly as we lower the external resistance and allow current to pass; and so, if we connected such a cell to the section of a large feeder (the resistance of which section in the present case is .001 ohm), the voltage would be infinitesimal, even at first, and would almost immediately disappear.

This paradox is readily solved, then, if we confine ourselves strictly to facts. It serves to illustrate the manner in which the "yellow journal" scientists palm off their imaginations for fact and "educate" a long-suffering public.

Trying to stop a 1000-ampere current in a circuit by means of a dry cell is like trying to take the strain off a 6-inch steel cable by tying a piece of string alongside of it. Well, it may help a little; but, as Josh Billings used to say, "It ain't worth bragging on."

V. C. WYNNE.

Utica, N. Y.

To the Editor of American Electrician:

The solution of the apparent paradox suggested by Mr. C. D. Blake in your November issue is quite simple, and need not involve any "astonishing assumptions" or the evading of the issue. At first sight it may seem puzzling, as it deals with what might be termed a "negative resistance," meaning a resistance which is less than zero; that is, one which not only does not tend to hinder the current, but assists it. A so-called "booster," for instance, might in some respects be considered such a negative resistance. But this term need not be used, as he might call it an "astonishing assumption."

The original line current in Mr. Blake's problem will simply tend to flow through the battery branch of the circuit in preference to flowing through that portion of the line wire which is between the battery connections, and which for convenience we will call A. The line current not only meets with less resistance in the battery branch, but it is even assisted in flowing that way by the battery which is in series with the generator. In other words, the line current will be "boosted" to the extent of 1.5 volts in the battery branch, while it will be checked to the extent of 1 volt in the other branch A. Or it might be said that the battery branch is a negative resistance, while the resistance of A is positive.

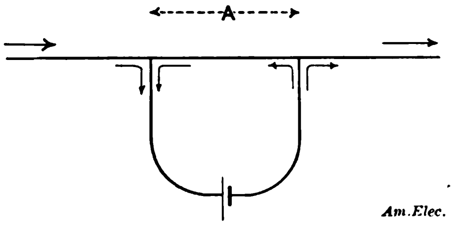


FIG. 1.

The actual results obtained will depend on the nature of the battery. If it does not polarize and has practically no internal resistance, like a very large accumulator for instance, the result will be that all the line current will be deflected from the portion A, will flow through the battery, will be "boosted" by the voltage of the battery and will then flow on through the rest of the line; but none of the original line current will then flow through the branch A; it will be stopped, as Mr. Blake supposes. Not only that, but a reversed current will flow in A, as the battery will discharge itself through it. The accompanying diagram, Fig. 1, shows how the currents will flow in this case. It will be seen that this is nothing more than an accumulator which is being short circuited by A, while it is discharging through the rest of the circuit.

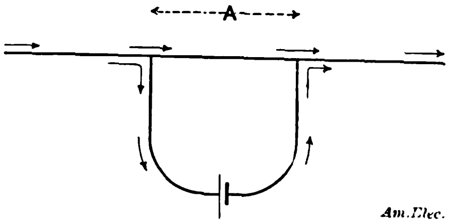


FIG. 2.

But if the battery is small, as compared with the line current, it will merely tend to act like the large battery, as it will soon be polarized by the large current, after which it will simply act like an electrolytic bath which is shunted by the resistance A, the line current flowing through it and through A in parallel and in the same direction. If it is a small accumulator it may tend to be reversed, but if a primary battery, it will take as much current as can be forced through it in the normal direction by the sum of its own voltage, and that at the terminals of the part A. The balance of the original line current will flow through A. This is shown in Fig. 2.

It naturally follows that if with a large battery the current in A is reversed, while with a small battery it is direct, there must be some condition under which there will be no current at all in A. This can readily be shown to be the case when the current in the battery circuit is that which it would give on short circuit, that is, when its effective voltage is zero.

The confusing feature in the problem is that the part A acts like a negative resistance toward the battery, tending not only to short circuit it, but to discharge it through even a less resistance than that of a short circuit. Moreover, the battery current, if the battery is small, will flow through the rest of the circuit and generator, and not through the part A.

If the two battery connections be moved very close together, a point will evidently be reached when there will be two currents flowing in opposite directions in different parts of the same wire. It will then be the equivalent of two independent circuits connected together at practically one point.

The original problem is nothing more than a potentiometer in which the battery is connected in the wrong direction. Or it is like the case of a single cell discharging in series with a large number of others, or in series with a dynamo; if a wire be connected across the terminals of this single cell a current will flow in that wire, either in one direction or the other, depending on the main current and the internal resistance of the cell. Or the curious case may exist of such a wire connecting the terminals of a cell and no current at all flowing through the wire. This will evidently be the case when the volts lost in the internal resistance of the cell are exactly equal to the e.m.f. of the cell (less the polarization, if any).

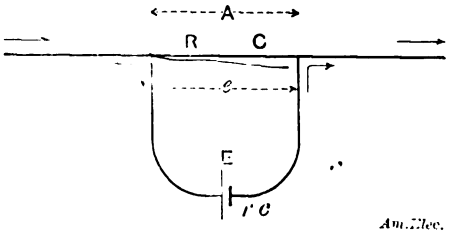


FIG 3.

The algebraic relations are very simple if proper care is taken with the signs. Referring to Fig. 3, let R, C, r and c, represent the resistances and currents in the two branches as shown; let E be the e.m.f. of the battery, and e the difference of potential between the ends of the portion of the feeder A. Then

$$e = C R$$

and

$$e = c r - E$$

The E in this is preceded by the negative sign because, being an e.m.f. or a rise of potential, its algebraic sign must be the opposite to that of a difference of potential like e, which is a fall of potential; it is in the omission of the proper sign that an error is likely to be made. Or, to put this last equation in a different form

$$e + E = c r$$

which means that the loss of voltage in the battery branch, namely c r, is equal to the sum of the true loss of voltage e and the voltage E, which has been added in that circuit; these two equations are evidently the same. Equating these two values of e gives

$$C R = c r - E;$$

from this and the fact that the sum of the two branch currents is equal to the original line current, all the various values can be found.

To illustrate this with an example, the values given by Mr. Blake may be substituted; that is let e = 1, E = 1.5 and assume the internal resistance of the battery with its leads to be 2.5 ohms; then the current in the battery circuit will be found to be 1 ampere; therefore the current in the portion A will be 99 if the original was 100. Dividing the value of E by r gives 0.6 ampere, which is the current which that battery would give on short circuit; this current will be seen to be less than the 1 ampere found above, showing, as was stated above, that the battery would be discharged faster than on short circuit. Substituting 0.6 ampere, 2.5 ohms, and 1.5 volts in the second equation gives e = zero, which shows that there would be no difference of potential at the terminals of the portion A in that case, and therefore no current. The current would therefore be stopped in that portion A if the original line current were only 0.6 ampere.

Carl Hering.

Philadelphia, Pa.

To the Editor of American Electrician:

There is an ancient mathematical riddle by which one is proved equal to two, which seems to me closely analogous to the problem propounded in my letter of November. My experience with such problems has been that the propoundee is first astounded with the absurdity of the result, and then prefacing his reply with a few remarks as to the ignorance of the propounder, proceeds to expose not his own ignorance (for the propounder does him more justice than to assume that he thinks one really equal to two), but his own precipitation. The sober second thought is seldom wrong, and as written communications are usually so composed, most of the foregoing replies are wholly or partly correct, but some of them are wholly or partly wrong.

Referring to the paradox, it is sufficient to say that the battery and the main e. m. f. are in series and the short length of cable constitutes a shunt between them. Current will flow in this shunt in the direction that the difference of potential between its ends dictates, and this depends on the current capacity of the battery and the resistance of its internal and external circuits. If these resistances are sufficiently low and the current capacity correspondingly great, the current in the short section of cable may be stopped or even reversed, the main current flowing through the battery. If, on the other hand, the resistance of the internal and external circuits is high, as would be the case with a small cell, the battery would fail to hold up its voltage and current would flow through it in precisely the same direction as if it were a simple piece of wire connecting the two points. If the points were placed near enough together, it might be possible to have an eddy, or an actual case of currents flowing in opposite directions in the same cable.

C. D. Blake.

New York, N. Y.

Electrical Catechism

253. What is meant by hysteresis?

Hysteresis is a sort of friction between the molecules of iron, or of any other magnetic substance, which causes the magnetization to lag behind the magnetizing current. The result is that when the magnetizing current increases the magnetization of the iron also increases, but when the current decreases the magnetization does not drop off exactly with the current; but for each value of the decreasing current the corresponding magnetization is greater than it was for the same value of the increasing current. This is illustrated in Fig. 1. When the current (or ampere-turns in the coil) increases from zero to a value represented by the length of the base line from O to A, the magnetization of the iron core increases by an amount represented by the ordinate or vertical distance from O to D. In the same way, a current OB causes a magnetization OG, and a current OC causes a magnetization OH. Now as the current becomes less, the magnetization corresponding to a given current is the same as before until the current becomes less than OB, and the resulting magnetism is less than enough to "saturate" the iron. As the current falls below this amount, the magnetism no longer falls off so rapidly as it increased, so that when the current has decreased to OA, the magnetism has only dropped to OF, instead of to OD. When the current drops to zero, some of the magnetism still remains for a time and may have the value of OE or less. The effect of hysteresis in instruments is that such instruments as depend upon the attraction or repulsion of a soft iron core by a coil, do not give the same reading for an increasing current as for a decreasing current except when the core is magnetically saturated.

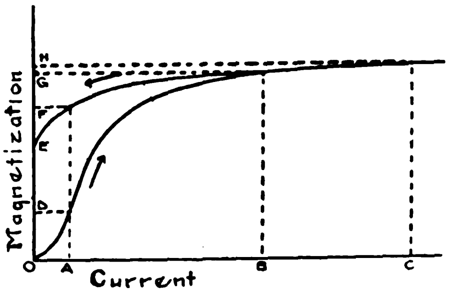


FIG. 1.

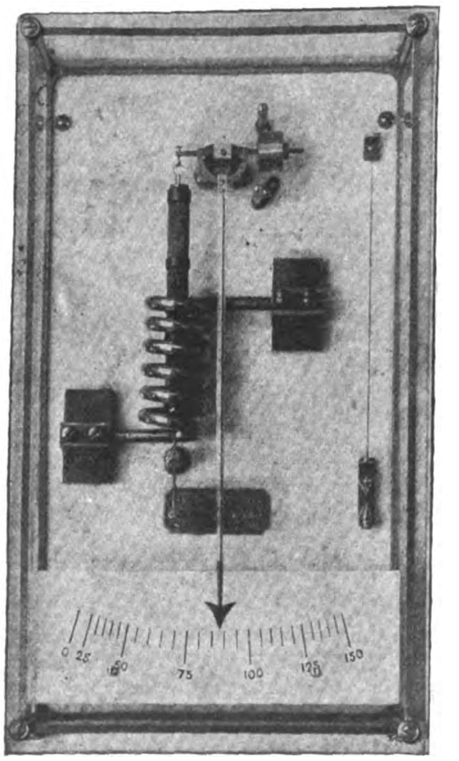


FIG. 2.

254. What instruments are based upon the attraction of a core into a coil?

Familiar examples are the ammeters used with Brush arc dynamos and those formerly sold with Edison dynamos and with Westinghouse alternators. One of the latter is illustrated in Fig. 2, in which the bundle of fine iron wires is seen hung from one end of a sort of balance having a counterweight at the further end and a long pointer hung below.

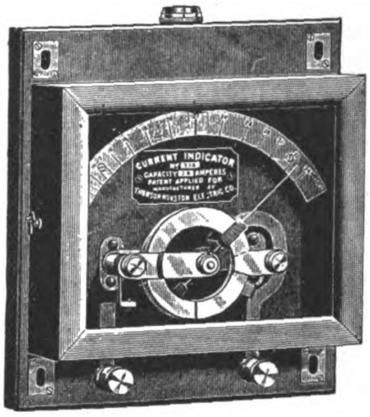
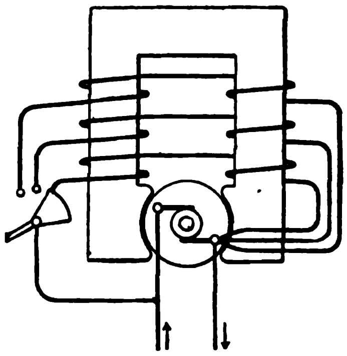


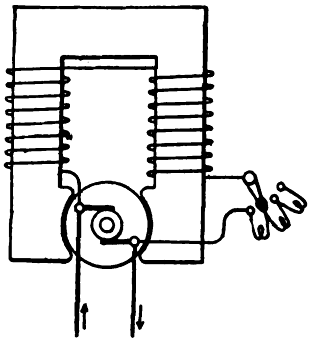
FIG. 3.

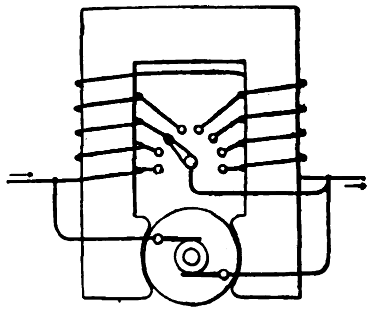
255. What is the principle of the eccentric instruments of Thomson-Houston and Fort Wayne companies?

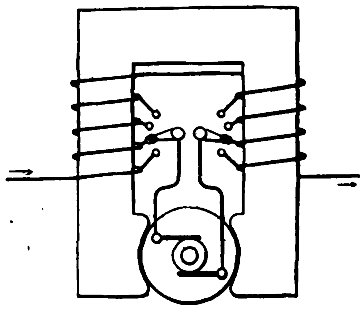
These instruments, illustrated in Fig. 3, have a stirrup of soft iron hung eccentrically in a coil in such a way that the iron stirrup is furthest from the coil when no current is passing; when current passes through the coil, the soft iron strip becomes magnetized; the magnetic lines of force about the coil always tend to take the easiest path; in this case, the easiest path is through the iron strip and the path becomes shorter and easier when the strip is closer to the coil. The attraction between the coil and iron causes the iron to move so as to approach the coil, but it can only approach the coil by turning around on the pivots. The weight is so adjusted as to tend to keep the strip furthest from the coil and thus gravity opposes the attraction of the strip.

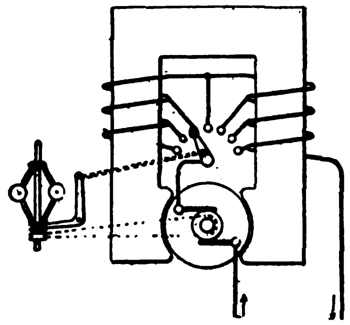
CONNECTIONS FOR MOTOR REGULATION.

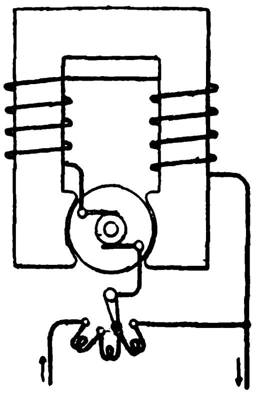

Commutator Field.

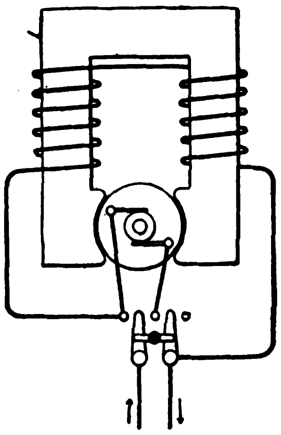

Shunt Field—Variable Resistance.

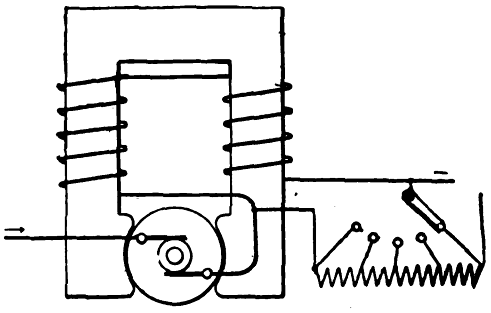

Sectional Shunt Field.

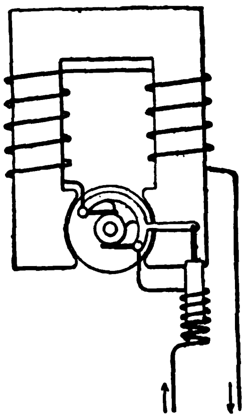

Sectional Shunt Field.

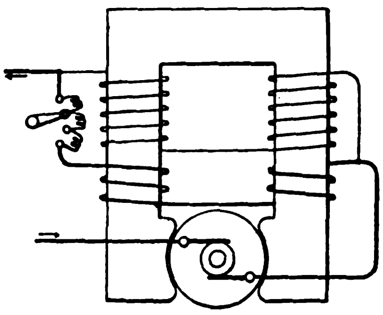

Motor Mechanical Regulation.

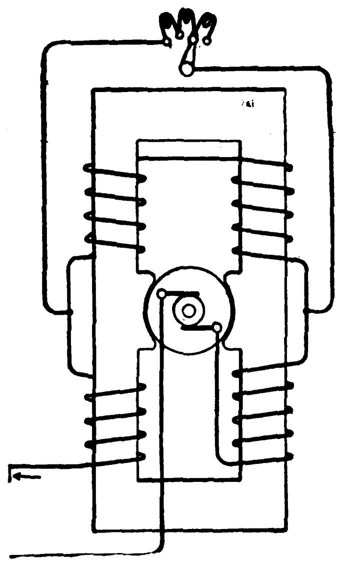

Shunted Series Motor.

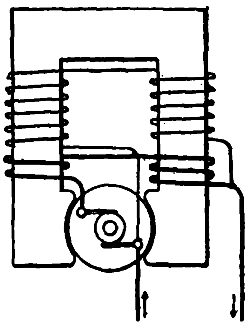

Motor Reversing Switch.

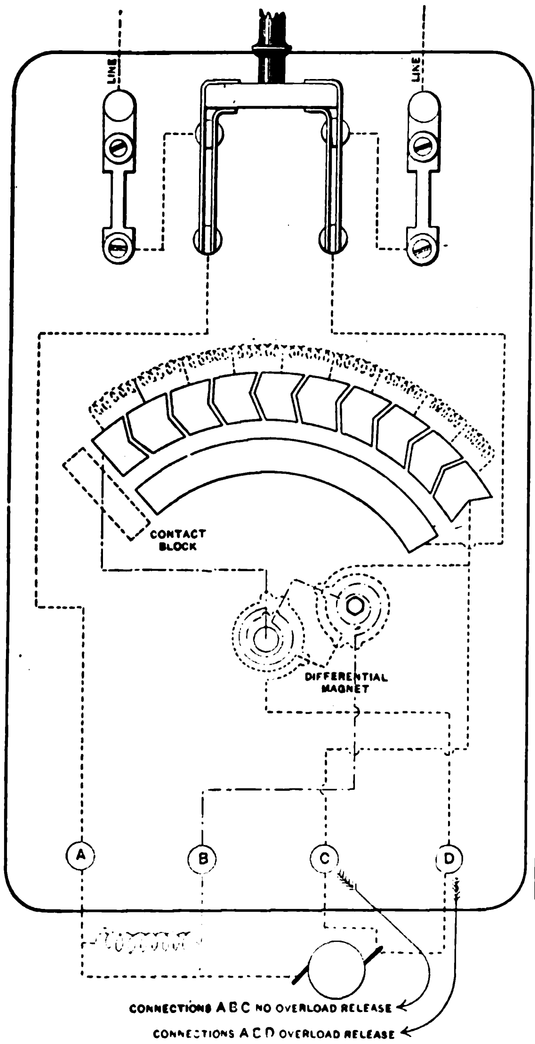

Shunted Series Field.


Solenoid Brush Shifter.

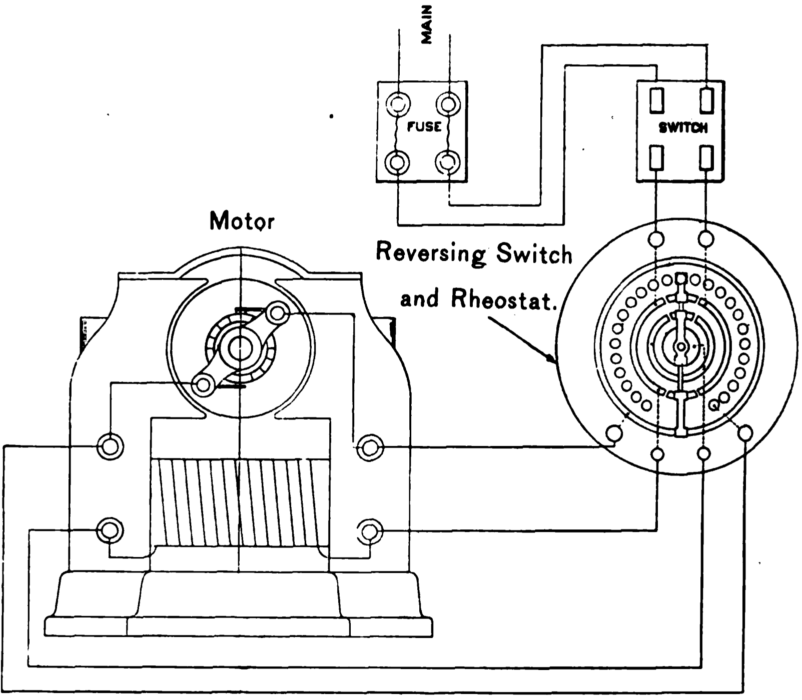

Compound Field, Variable Series Coil.

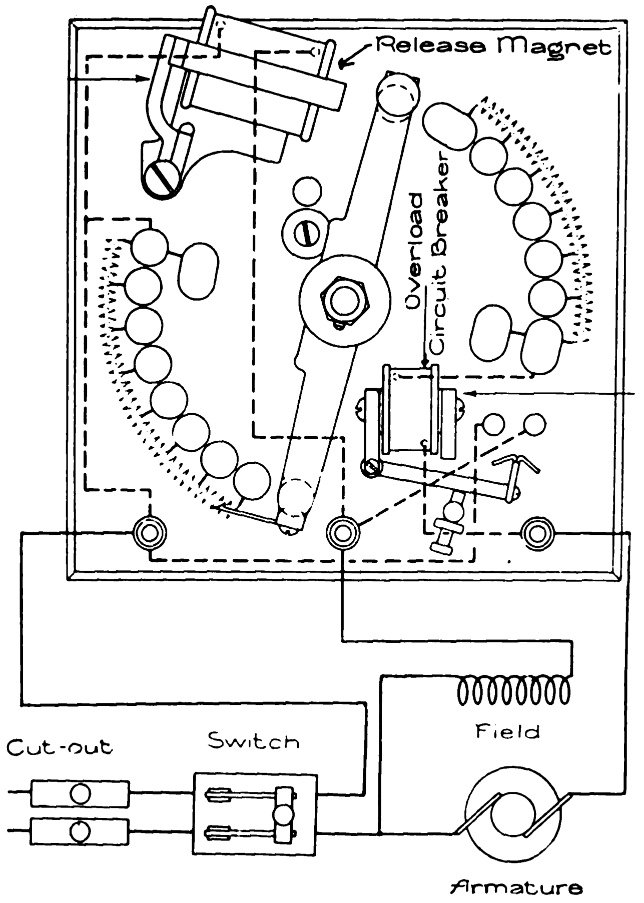

Series Field, Partially Shunted.

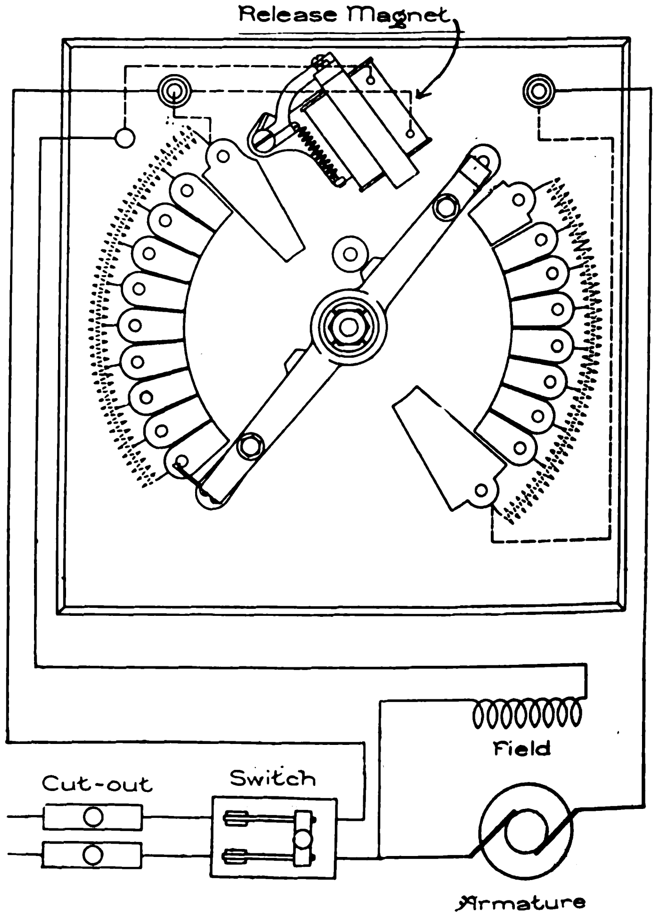

Differential Field, Long Shunt.


LINE
LINE
CONTACT BLOCK
DIFFERENTIAL MAGNET
A
B
C
D
CONNECTIONS A B C NO OVERLOAD RELEASE
CONNECTIONS A C D OVERLOAD RELEASE

MOTOR STARTING RHEOSTATS.


MAIN
FUSE
SWITCH
Motor
Reversing Switch
and Rheostat.


Release Magnet
Overload Circuit Breaker
Cut-out
Switch
Field
Armature


Release Magnet
Cut-out
Switch
Field
Armature

Queries and Answers

What are the best glasses to use for arc lamp testing? R. T. K.

A combination of green and yellow glasses.

How may an electric bell be safely installed on an electric light circuit? F. A.

In series with a lamp of the same voltage as that of the circuit. If a large bell, two lamps in parallel series may be required.

Can the winding of an ordinary telephone generator be so connected as to give a continuous current? J. E. R.

No; for a continuous current an armature with a commutator having many segments, would have to be substituted.

1. What is the inside diameter of the ring in the ammeter described on p. 469 of October issue? 2. What is the size of the iron screws, S and S? 3. Will ordinary No. 10 magnet wire be suitable for winding the coils? D. H.

1. 4½ ins. 2. About 1½ ins. long under the head and about a quarter inch diameter. 3. Yes.

I use current from a 107-volt circuit for a dental lamp, and would like to have means for lighting an alcohol lamp from the same circuit. How may this be done? A. R.

Put a 32 c.p. lamp in series with a spark coil, and make and break the circuit between the metal terminals at the wick. The coil can be made by winding a few pounds of No. 14 wire on a core of soft iron wire.

What do the initials S. K. C. on machinery of the Stanley Company signify? R. J. F.

The initials are those of Mr. William Stanley, Jr., founder of the Stanley Electric Manufacturing Company; Mr. John F. Kelley, electrical engineer of the company, and Mr. C. C. Chesney, superintendent of works.

How does a step-up transformer differ from an ordinary transformer? A. D.

Not at all, except in constructional features, due to the very high voltage and large capacity. An ordinary 1000—100 volt transformer would be a 100—1000 volt step-up transformer if its secondary were connected to a 100-volt circuit, the primary then developing 1000 volts.

Can a multipolar permanent magnet be made? If so, what would be the best way to magnetize it? A. C.

The most practicable way to make a mulipolar permanent magnet would be to build it up from a number of ordinary horseshoe magnets, magnetizing the latter by bridging with the legs the field gap of a dynamo.

In what manner does the self-induction of a telephone line counteract the capacity of that line? C. H.

The variable field of force that sets up the capacity effect also sets up an inductive effect, but the e.m.f. of one is opposed to that of the other. Consequently, if the capacity effect, or e.m.f., is the larger, it will be decreased by the amount of the inductive effect, or e.m.f., or vice versa.

How can I restore dry cells to their original power? W. A. M.

Send a current of one or more amperes through the cell, being careful to connect the positive pole of the cell to the positive side of the circuit from which current is derived. If two amperes are used, the cell should be in circuit about thirty hours, and proportionately with other currents. It will scarcely pay to restore dry cells.

Why does moving out the iron coil or shoving in the brass case of a medical coil reduce the strength of the shock? L. N. S.

In the first mentioned case withdrawal of the core reduces the number of lines of force acting on the secondary. In the second case the eddy currents set up in the brass cylinder about the primary set up lines of force that neutralize part of the lines of the primary.

How much current can be carried in a piece of copper ½ in. x 1-32 in. in cross section? L. L.

According to the navy rule of 1000 amperes per square inch the bar would carry 15.6 amperes. Practically, it will carry very much more with safety from overheating, all rules as to carrying capacity referring to inclosed and insulated conductors, and to a rise of but from 15 to 20 degs. in temperature.

I have a 1000-volt alternator which I would like to change to 2000 volts. Could this be done by doubling the speed or changing the connections at the collector rings? E. W. B.

The speed could not be doubled with safety, and unless the armature winding is in multiple it would have to be replaced by wire of double the length and half the cross section. Practically this could not be done, owing to the space that would be required for the extra insulation for 2000 volts.

What is the formula for calculating a tinfoil condenser, paraffined paper being used? F. F. K.

In the following formula A is the area in square feet of one side of the foil; t the thickness of the dielectric in inches; M the capacity in microfarads; K the specific inductive capacity:

$$A = \frac{15.458 \times t \times M}{K}$$

The specific inductive capacity of paraffine is about 2.4, and that of paraffined paper may be assumed to be the same.

I am in charge of three direct-connected compound-wound dynamos running an incandescent circuit and connected in parallel. At full load they give 750 amperes each at 120 volts, or the equivalent of 120 h.p. each. An indicator card shows that two of the engines are developing 156 h.p. each, and a friction shows that each engine develops 15 h. p. running light. This gives 21 h.p. unaccounted for, and I shall be obliged if you will tell me where it goes. J. S.

The loss is in the generator windings and in additional mechanical friction, the latter, however, forming but a small proportion. Such a loss is not excessive, as from the data given the machines work at an efficiency of about 85 per cent at full load.

The capacity of a 7-plate pasted storage cell had dropped from 120 to 30 ampere-hours. The sides of the negative plate facing the positives are rough and covered an eighth of an inch deep with a grayish deposit, though twice cleaned lately. In the bottom of the cell there is a grayish deposit instead of the usual chocolate-colored one. What is the trouble? A. M.

The cell is evidently sulphating, and the process will continue, if not checked, until the cell is dead. The most common cause of sulphating is internal short-circuiting; to remedy, carefully examine if there are flakes of active material or other conducting substance connecting the plates. If this has already been done and the cell does not revive under continuous but moderate overcharging, alternated with light discharging, there is something else the matter. A little common salt, accidentally spilled into the cell, would make it act in the way described, and as battery solution is very cheap and since other deleterious substances may have got into the cell, it would be better to throw out the solution, wash out the jar, rinse off the plates with pure water or battery solution, and refill with solution made from pure acid and water. In the type of cell referred to, the negatives often give out before the positives.

What must be the length of a piece of German silver wire .15 in. in diameter, for a resistance of 200 ohms? J. N.

The resistance of a wire is expressed by the following formula:

$$R = \frac{LK}{D^2}$$

where R is the total resistance of the wire, L is its length in feet, D^2 is the square of the diameter in mils—that is to say, in thousandths of an inch—and K a certain constant which is equal to the resistance of a piece of wire 1 ft. long and 1 mil in diameter, and is known as the specific resistance of the metal. German silver has a specific resistance constant, taking the foot mil as a basis, of 125.9. Applying the formula to the case in hand we have

$$200 = \frac{L \times 125.9}{(150)^2}$$

whence $L = 35{,}742$ ft.

How is the mean spherical c.p. of an electric arc or incandescent lamp taken? J. L.

The spherical c.p. of a lamp is taken by rotating the lamp through equal angles in a number of different vertical planes passing through its center, taking the c.p. at every step. The average of the c.p. at all these angles is the mean spherical c.p.

How is the starting resistance connected to the rotating part of an induction motor? P. T. C.

The starting resistance is connected in series with the winding in which the currents are induced. This may or may not be the rotating part. The induced winding is a closed circuit, but on starting is opened and a resistance inserted in order to prevent the induced currents from attaining too great a value. The resistance is usually cut out by means of a sliding collar on the shaft, which short circuits it.

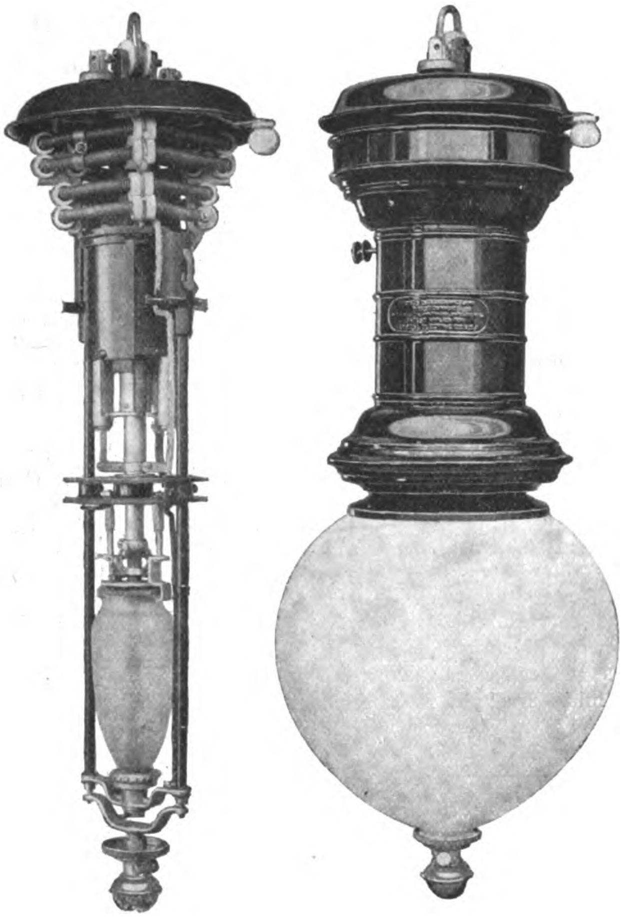
Is the heat radiated from an electric lamp proportional to the watts or to the c.p.? H. K.

Of the energy from an incandescent lamp about 3 per cent. is radiated as light and the remainder as heat. In an arc lamp the efficiency is somewhat better, bearing the ratio of 15 and 85. If the lamp is placed in an enclosed space, the light is ultimately transformed into heat by radiation.

New Apparatus and Appliances

220-VOLT INCLOSED ARC LAMP.

A perfected form of carbon feed arc lamp for direct connection across 220-volt mains is being placed on the market by the General Electric Company. It operates with 150 volts at the arc, takes a normal current of 2.5 amperes, and with one trimming has a life of from 130 to 150 hours, requiring no attention during that time. The carbons are so proportioned that the upper carbon at the end of any run of 130 or 150 hours may be placed in the lower carbon holder for the next run. The light is of less volume and more violet in color than standard 110-volt lamps, but the advantages of a 220-volt lamp capable of independent operation sometimes compensate for the diminution of light, as compared with the 5-ampere lamp for use two in series across 220-volt mains. A variable resistance at the top of the mechanism allows the use of the lamp on circuits of from 210 to 250 volts, and disconnection from the circuit is effected by a quick-break switch applied to each lamp.



INTERIOR AND EXTERIOR OF 220-VOLT ARC LAMP.

The 220-volt lamp is weatherproof, and may be used without a hood. It is especially suitable for lighting vestibules, doorways, window fronts, etc. It may be used with the closed outside globe, as shown in the illustration, or with the single globe and flared reflector. The casings are of several designs, the standard weatherproof casing being finished in black enamel.

ACETYLENE SEARCHLIGHT.

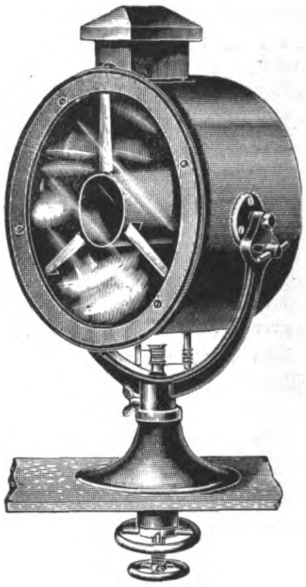
One of the first applications of the wonderful acetylene light to commercial use was in the form of a searchlight. One ½ ft. burner only, with a candle power of about 25, can be manipulated by reflection so as to give an effective beam of over 2000 c. p., the cost of running this being from ½ to 1 cent per hour, according to the quantity of carbide purchased at one time.

The value of this light is thus evident, and for any form of work at night the simplicity of the apparatus, its light weight and small cost render it a great boon to contractors.

While its general uses are too numerous to mention, one of its greatest advantages is when used on small boats for making landings, picking up buoys and running up channels at night.

The cut herewith shows an acetylene searchlight mounted upon a pilot house stand, as intended for the roof of a pilot house. The motion around the vertical axis is given by the large wheel, and the motion around the horizontal axis by the small wheel, the shaft of which passes through the vertical axis.

The gas connection is made through a pipe inside of the shaft of the small wheel and extending below it, with a swinging joint, so that the piping to the generator supplying the gas can be permanent, it thus not being necessary to use rubber tubing inside the pilot house. Some idea of the power of this light can be gained from the fact that objects within a radius of 600 to 1000 ft. away can be distinguished under most favorable conditions.



ACETYLENE GAS SEARCHLIGHT.

Of course, the light can be mounted on other stands than the one shown. There is an adjusting screw at the back for adjusting the light to concentrate the rays of the light or disperse them.

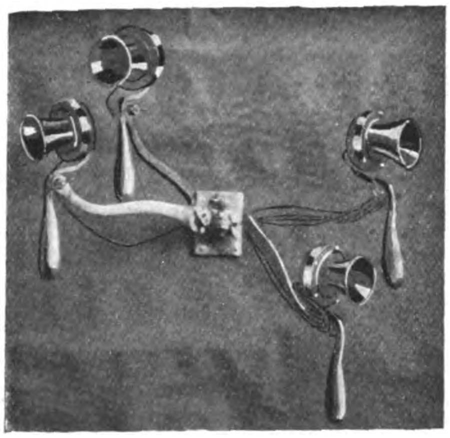
The horizontal cylinder shown inside the searchlight is intended to cut off the direct rays from the burner, which would otherwise spread out too much; when necessary, the cylinder can easily be removed. Two sizes of this light are made—one 14 ins., outside diameter; the other 12 ins., with a deeper reflector. The power of these two sizes is about equal. The small one is best adapted to small boats. Many of these lights are being used on boats in the rivers of the South, as well as on some of the smaller ocean-going vessels.

In the form of a signal light it is used by the United States Government, the flash being obtained by the use of a key which shuts off the gas as required. The key resembles the Morse telegraph key. Experiments at Sandy Hook showed that flashes could be seen for over thirteen miles, and it is reported they have been seen for over thirty miles.

These lights are manufactured by J. B. Colt & Company, 3 West Twenty-ninth Street, New York.

TELEPHONE TRANSMITTER ARM.

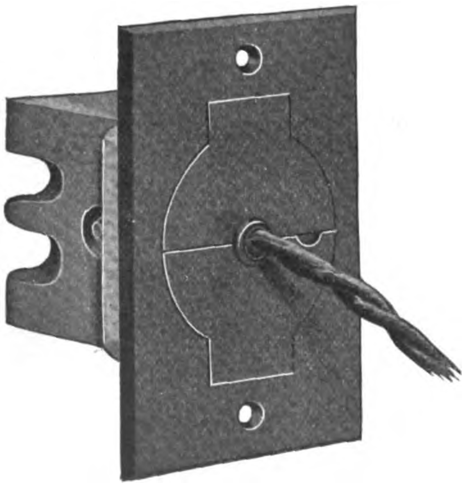
The cut shown herewith illustrates a new telephone arm to which considerable importance is attached, on account of its construction allowing the transmitter to be held constantly in a horizontal position, thereby keeping the carbon in the transmitter always in the same relation to the diaphragm. The old style of telephone arms whenever raised throws the granules back from the diaphragm, and, when lowered, throws them against the diaphragm, thus causing constant disarrangement of the granules and interfering with good transmission. With the arm illustrated above it is claimed that this trouble is obviated. A transmitter used in connection with this arm will never pack, as the constant motion tends to keep the carbon loose and free in the transmitter. This appliance is manufactured by A. Y. Gordon, Massillon, Ohio.



TELEPHONE TRANSMITTER ARM.

FLUSH PLUG RECEPTACLE.

A flush plug receptacle, containing some interesting features, recently placed on the market, is shown in the accompanying illustration. In this type of receptacle the plug, when in place, does not project beyond the face of the receptacle plate, thus avoiding not only unsightliness in appearance, but the constant danger from the plug being struck and damaged. When the plug is in place it is entirely covered by the doors of the receptacle, an extension acting as a bushing and preventing the cords from being cut by the metal doors. Among other advantages claimed for the plug is that it is easily and quickly wired, a large binding post being provided, while the slots and holes in the porcelain are amply large to admit of the wire being slipped in. It has large, well-fitting contacts, which are always under tension, and in the box is a porcelain barrier between points of opposite polarity, thus entirely eliminating possibility of accidental short circuits. This plug is made to fit standard iron boxes, and is manufactured by Zimdars & Hunt, 127 Fifth Avenue, New York.

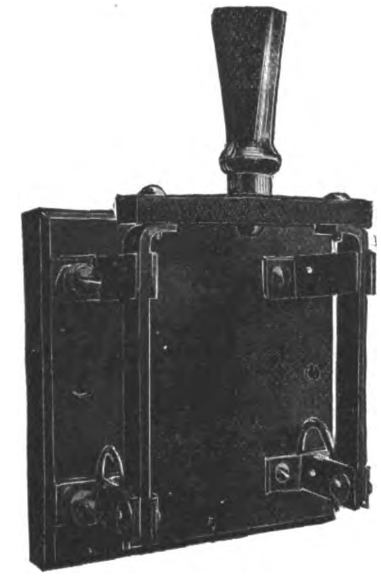


FLUSH RECEPTACLE.

BULL DOG SWITCH.

The switch illustrated herewith, known as the Shawmut Bull Dog switch, was devised to meet the demand for a strong, substantial entrance switch at a low price. It is made to meet the underwriters' requirements, and gives in addition a spring to suit a certain class of customers who prefer this feature. The makers state that to insure a surplus of strength the switch, whose capacity is 25 amperes, is made of 50-ampere stock.

The appearance, as will be seen from the cut, is unusually neat, since the rolled copper shows off to advantage against the handsome Monson slate. The switch described is made by the Shawmut Fuse Wire Company, 93 Federal Street, Boston.



BULL DOG SWITCH.

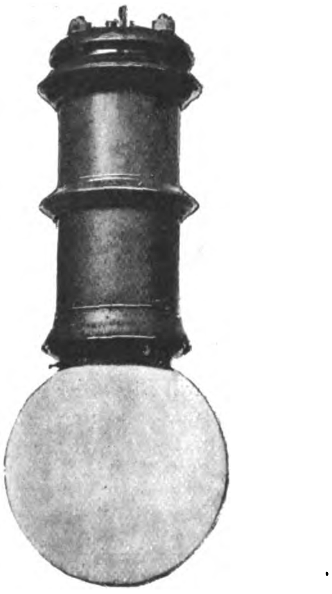
C & C—FORBES GENERATING SETS.

The following illustration shows a C & C generator connected to a Forbes vertical engine of the marine type, which combination is being placed in a number of sizes on the market by the C & C Electric Company of New York, and known as C & C—Forbes sets. The Forbes engine is well built of the best material, and, while of unusual lightness, is yet strong and serviceable. The governor employed is of Rites type, by means of which close regulation is assured. One of the special features of the set is the combined coupling and balance disc or flywheel. Among other features of this engine is its remarkable balance, the engine running so noiselessly as to give no sound audible beyond a short distance. The economy of the engine is unusually high, doubtless due to its very small clearances. The dynamos used in these sets are the well-known C & C open or closed ironclad type, which are particularly adapted for the service for which these sets are intended. The sets are produced in various capacities ranging from 2½ to 17 k.w.

MARINE GENERATING SET.

THE AMERICAN ENCLOSED ARC LAMP.

The accompanying cut illustrates a new type of inclosed arc lamp, known as the "American." The construction throughout has been made substantial, and the mechanism simplified so as to reduce to a minimum the liability to get out of order. The contact is permanent without the use of brushes, and the question of trimming, always an important one in inclosed arc lamps, has in this lamp received special attention. The outer globe can be easily and safely lowered and the inner globe removed when retrimming has to be done. The inner globe is made of heat-resisting and tough glass that will not fracture from any change of temperature.



A NEW ENCLOSED ARC LAMP.

The length of the lamp over all is 29 in., and it is made in japanned iron and brass for outside service. For inside use it is finished in many fancy designs in ornamental brass. The maker is Chas. J. Bogue, 213 Centre Street, New York.

NEW LAKON TRANSFORMERS.

A new type of Lakon transformer is shown in the accompanying illustrations, which show several interesting features. Though of the oil type, the transformers may be used without oil, but the company does not advise its omission.

The method of hanging is shown in Fig.

1, and is extremely simple. The light hanging hook can be held in position and lag screws and bolts put in place by one man, and when the transformer is hoisted to be hung upon the hook it can be swung into position and quickly and easily lowered into the hanging hook.

In order to secure a high all-day efficiency the transformers have been designed for a very low core loss, and good regulation is secured by a symmetrical arrangement of the windings, shown in Figs. 2 and 3, and a liberal use of copper. The primary and secondary cables are brought out on opposite sides of the case through heavy porcelain bushings, and are firmly cemented into the porcelains, thus obviating chafing or wearing away of the insulation where the cables come through the case.

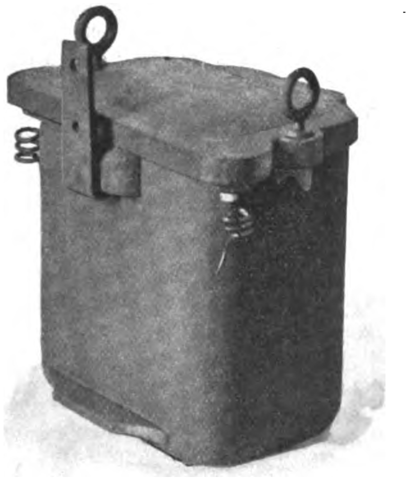


FIG. 1.—LAKON TRANSFORMER.

The aging of iron has been investigated by this company, and they state that they will replace within two years any transformers that will show any marked change in efficiency due to aging of iron. The coils are so arranged that a very large surface of copper is exposed to the oil, thus keeping the temperature down to a low figure.

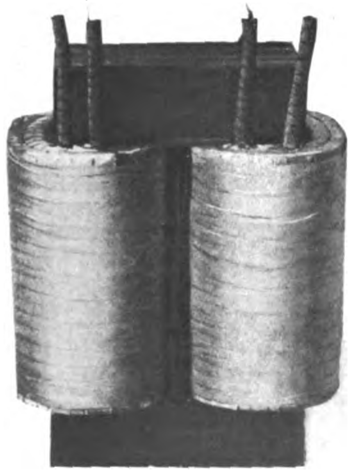


FIG. 2.—LAKON TRANSFORMER.

The transformers are designed to withstand a very high break-down test between primary and secondary and between primary and core, while a very high insulation between primary and secondary is a safeguard against burn-outs from lightning. A transformer cannot be made in which the insulation in itself is enough to withstand the extremely high potential of a lightning discharge, and the company advocates a more general use of lightning arresters. Metallic ground shields are placed in transformers when specified, but the company do not advise the use of them, on account of the increased danger of a puncture in the insulation due to a lightning discharge. The ground shield being connected to earth, affords a free path for lightning, and they believe that the transformer is more liable to be burned out by lightning when ground shields are attached. The ground shield will prevent the lightning discharge from appearing on the secondary circuit, but it is not a protection to the transformer.

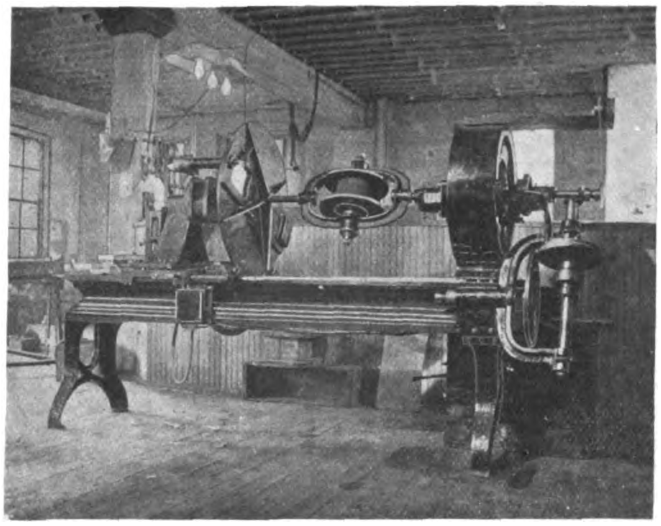
The manufacturers are the Lakon Company, Elkhart, Ind.

COIL WINDING MACHINE.

In these days of close competition every means of reducing cost is of the utmost importance, and this applies particularly to such labor consuming operations as coil winding, if not done by special machinery.

The accompanying illustration is made from a coil winding machine which has been in operation 18 months, doing the work of eight winding machines of another type, which it displaced. It will be seen from the cut the form on which the coil is to be wound is rigidly attached to a frame mounted on a carriage; the carriage is moved forward and backward corresponding to the size of wire and length of form to be wound. The reel from which the wire is taken is placed in a yoke forming part of main shaft, with which it rotates, turning simultaneously on its own axle, and unwinds the wire in proportion as it is placed on the coil. By the introduction of a novel tension device, through which the wire passes before it is laid on the form, the bulging of the wire on a square coil is entirely avoided.

The machine is motor driven, with a controlling device attached to the carriage so as to be within reach of the operator. The reversing mechanism is also operated electrically. The machine is perfectly automatic in all of its movements, registers the number of turns on the coil and reports any defective insulation which may pass through tension device. All adjustments are easily made, and the carriage feed can be adjusted to 0.001 in., so as to insure a solid coil. The makers of the machine are the Jantz & Leist Electric Company, 222 East Ninth Street, Cincinnati, Ohio.



MACHINE FOR WINDING MAGNET COILS.

A SMALL STURTEVANT GENERATING SET.

The "Midget" generating set, illustrated herewith, is probably one of the smallest and most perfectly designed direct-connected machines ever constructed. The photograph is from one of a number recently built by the B. F. Sturtevant Company, of Boston, Mass., for the United States Navy, to be used in torpedo-boat service. The salient features of the design are reliability, low temperature, good regulation, ability to stand continuous overloads, a minimum of attendance, high weight efficiency and great compactness.

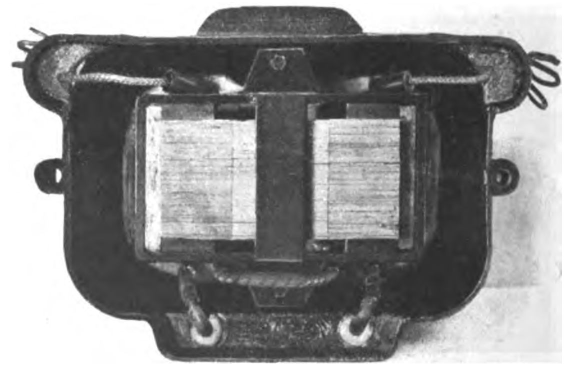
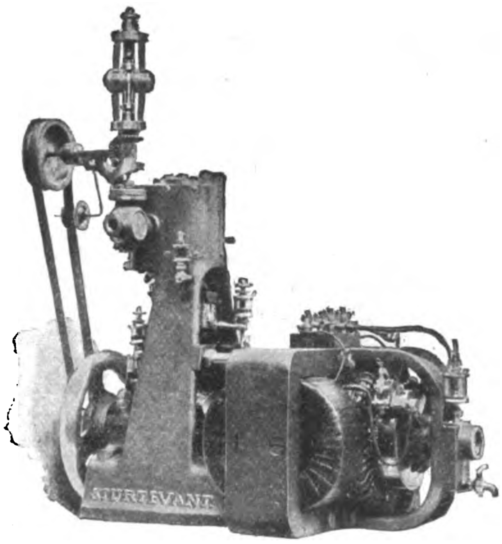


FIG. 3.—LAKON TRANSFORMER.

This generating set was designed to be

able to develop its rated output continuously with absolutely no sparking at the brushes and with a temperature rise not to exceed 60 degs. F., while the total weight of the engine and dynamo complete, ready for steam pipe, was limited to 500 lbs. for a rated capacity of 1.5 k.w. The speed adopted was 1000 r.p.m., and as the engine weighed 150 lbs. complete, the weight of the dynamo could not exceed 350 lbs. In the finished design of the generator this weight was reduced to 250 lbs., of which 75 lbs. was the weight of the armature complete, making the total weight of the entire set only 400 lbs.; that is, 100 lbs. within the limit. This brought the weight efficiency of the output complete to 0.266 lbs. per watt output at rated capacity.



SPECIAL MARINE GENERATING SET.

In order to insure a steadiness in running, as well as to economize in head room, the center of gravity was kept as low as possible by the adoption of the consequent-pole type of magnetic circuit, giving a four-pole field, with only two field coils, which coils, being placed on the horizontal pole-pieces, reduce the height of the frame and consequent height of the shaft center to a minimum, and at the same time render a sub-base necessary.

The field magnet consists of a wrought iron forging, to which are bolted the horizontal pole-pieces. The armature is of exceptionally large diameter, in order to facilitate ventilation and present as great a radiating surface as possible.

The core discs are mounted on a brass spider, having a flange support for the armature coils on the back end and an extended sleeve for support of commutator on the front.

The ventilation of the core is facilitated by means of air ducts placed in the center and at each of its ends, which air ducts consist of a series of radial vanes, which, when rotated, act as a centrifugal blower. As the back end of the spider is completely closed and oil proof all the air is drawn through the commutator, which is of skeleton construction and also of very large diameter.

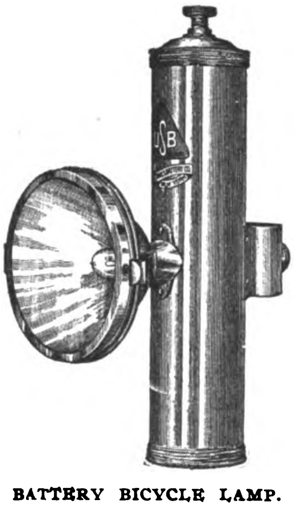
The brush holders are of the reaction type, two only being used, as the armature is of the two-circuit, four-pole, barrel-wound type, without cross connections. The brush yoke is supported by a projection from the out board bearing.

The generator is compound-wound for a constant e.m.f (at constant speed) at all changes of load, from no load to 50 per cent overload, and can stand this variation without sparking at the commutator or any movement of brushes. A continuous overload of 25 per cent. can be carried with safety. The weight efficiency at the rated output is remarkable, considering the amount of overload that can be carried and the low temperature rise.

The engine upon which the effectiveness of the combination depends is of special construction, designed to form a symmetrical part of the whole machine. Its single cylinder is 2 ins. diameter by 2 ins. stroke, all parts are provided with continuous oiling devices, the bearing surfaces are large and carefully finished, and every feature essential to sustained operation at 1000 r.p.m. has been introduced.

ELECTRIC BICYCLE LAMP.

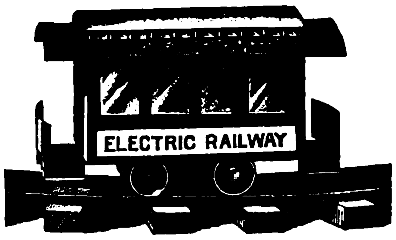
The bicycle lamp outfit shown herewith is actuated by a battery, which, when exhausted, is returned to the makers, or an agent, for restoration, a new battery being supplied in exchange for a small sum. The lamp contains two cells, having the appearance of sealed rubber cylinders, with contact-disc on each end. The mere placing the cells in position in the lamp case makes the necessary electrical connections. To light the lamp it is only necessary to turn the screw at the top. The makers are the United States Battery Company, 256 West Twenty-third Street, New York.



BATTERY BICYCLE LAMP.

TOY ELECTRIC RAILWAY.

With the approach of the holiday season, manufacturers of toys are announcing their 1898 novelties, and among the most interesting of these is an electric railway, shown in the cut. The car is 7 in. long, 4½ in. high, has iron wheels and is made of polished brass. The car runs on a circular track 3 ft. in diameter and of 2-in. gage, made of polished rolled steel, the speed being about 150 ft. per minute. The current is conducted through the rails and wheels of the car to the motor. The battery consists of three zinc-carbon elements, which may be set up by the purchaser in ordinary table glasses, the solution for charging being furnished with the battery elements.

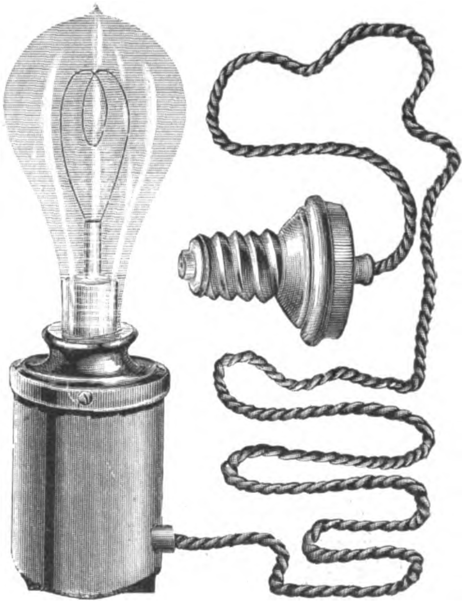


TOY RAILWAY CAR.

This toy is made by the Carlisle & Finch Company, 828 West Sixth Street, Cincinnati, Ohio.

MAGNETIC LAMP HOLDER.

An interesting form of lamp holder is shown in the accompanying illustration, which will be found particularly useful in machine shops, as it can be so placed as to have the light shine exactly where wanted when working with the different kind of tools. Another application is in boiler shops, as the holder can be fixed at any desired position within a boiler. In fact, it will find application wherever a portable light is needed and where iron is present.

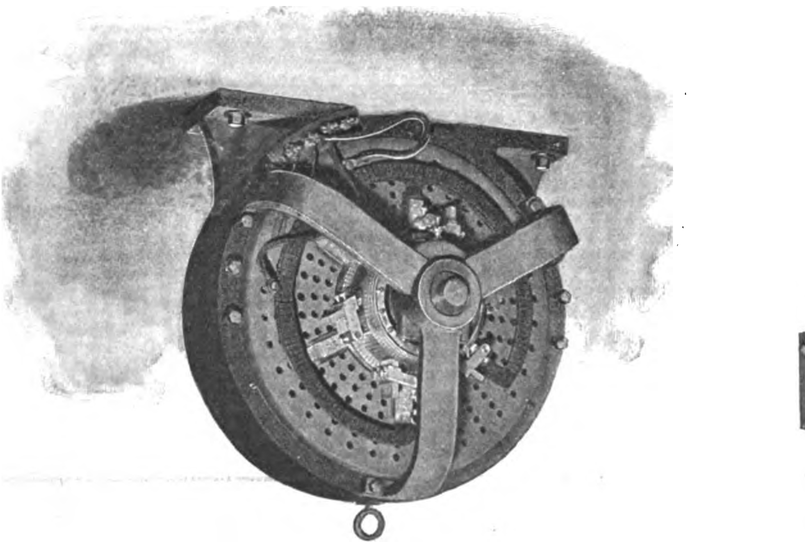


PORTABLE LAMP HOLDER.

The current for the lamp passes through a coil of low resistance, thereby magnetizing the lamp holder and causing it to adhere to any iron surface against which it may be placed. This very useful appliance is made by Jenkins Brothers, New York, the well-known manufacturers of valves and packing.

DIRECT-CONNECTED, CEILING-TYPE MOTOR.

We illustrate below a new motor made especially for direct connection to machine tools, printing presses, line or countershafts, etc., and which is of an exceptionally compact design and constructed for direct attachment at minimum expense. Both armature and pole pieces are of laminated steel. The armature and commutator are mounted on an independent spider, which is bored to fit the shaft of the tool to be driven. Ample room between spider and core is left for ventilation, and radial apertures are provided running from center to circumference for the same purpose. As a result of this construction and the careful design otherwise, the temperature rise of one of these machines tested under ten-hour continuous run, loaded, was less than 10 degs.



CEILING MOTOR FOR DRIVING COUNTER SHAFT DIRECT.

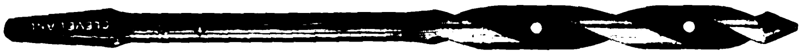
Cast-iron perforated plates are fitted on each side of frame, protecting both the fields and armature, and in special cases the commutator has been similarly protected, although this is not ordinarily necessary. The brushes are of carbon, and are clamped positively in the holder, the construction of which is such that the tension can readily be adjusted. This type of holder is far superior to that of any depending on a sliding contact between the carbon and holder.

The bearings are of bronze, of the ring oiling, self-aligning type, and are carried on three arm spiders attached to the frame, thus making a machine entirely self-contained and very compact. Oil wells of ample capacity are provided. The machine is built inverted as a ceiling motor, for which use a simple and efficient belt tightener is provided.

These machines are made in six sizes, all based on 100 r.p.m., by the Triumph Electric Company, Cincinnati, Ohio.

AN ELECTRICIAN'S DRILL.

The useful tool shown in the accompanying cut is the result of the thought aroused in an inventor after noticing the trouble often encountered by electricians in getting a small wire through a hole after it has been bored in a beam or partition. The tool consists of a twist drill, with several small eyes through the web or center. After the hole is drilled in the wood the end of the wire is inserted in one of the eyes in the drill, the latter is then inserted in the hole, and the wire pulled through from the other side. Several eyes are pierced in the drill, so that if one part should wear or break away another can be used. The manufacturers are the Cleveland Twist Drill Company, of Cleveland, Ohio.



COMBINED DRILL AND WIRE-FISHING TOOL.

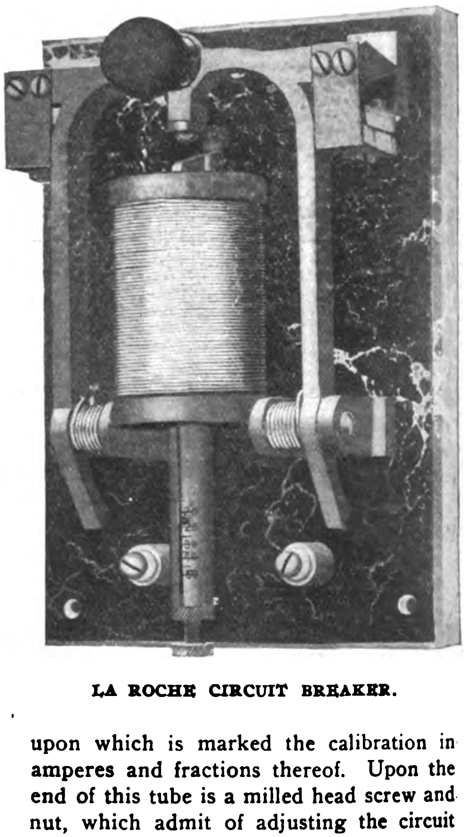
NEW LA ROCHE CIRCUIT BREAKER.

In the new type of circuit breaker, illustrated herewith, the carbons are attached to the breaker parallel to the clips. As the breaker opens, the carbons attached to the blades move with a cam motion, which keeps a rubbing contact on the stationary carbon until the blades are at a safe distance from the clips. The circuit is then finally broken through the carbons and below the clips, thus preventing burning ot the clips or blades.

The blades are of the wedge type and close into "V" shape clips. These are laminated and flexible to an extent that they adapt themselves to the shape of the blades, and absolute tight contact is thereby formed. The latch and trigger are made of case-hardened steel, and are of the compound lever type, so constructed as to permit of a very weak solenoid being used, as the force of the blow required to operate the breaker will be very small. This method of construction is new in this style of instrument.

The hinge posts and blade arms do not carry any current, and it will be noticed, by referring to the cut, that there are two phosphor bronze springs in each hinge. These springs are quite weak, and only sufficiently strong enough to give the switch a quick and sharp break. Owing to the peculiarly shaped blades and clips, it is an impossibility for the circuit breaker to stick, and the construction of the clips tends to throw the blades out by their own action. This breaker would really operate without these springs in the hinge, the springs being there only to assist in quickening the motion.

On the bottom of the lever arms are two projections which are parts of the blade frame, and come in contact with a buffer, so that when the breaker is opened and performing its function the blow on the hinge post is reduced to a minimum. Underneath the solenoid is a copper tube, upon which is marked the calibration in amperes and fractions thereof. Upon the end of this tube is a milled head screw and nut, which admit of adjusting the circuit breaker to open at any desired point within its guaranteed high or low ampere ratings.

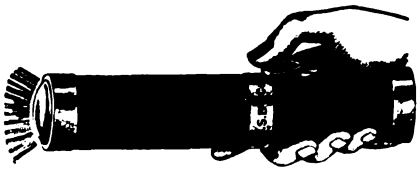


LA ROCHE CIRCUIT BREAKER.

This new type of circuit breaker, which is manufactured by F. A. La Roche & Company, 13th and Hudson Streets, New York, is made in sizes from 15 to 500 amperes.

SAFETY POCKET LIGHT.

The accompanying illustration shows a handy electric flash or emergency light for the use of watchmen, engineers, electricians, miners and others. The makers state that it will give from 6000 to 8000 illuminations before needing recharging. While not intended for prolonged burning, it gives excellent results for emergency uses, as in the examination of machinery, where a flame lamp would be unsatisfactory, or where there is danger of explo-



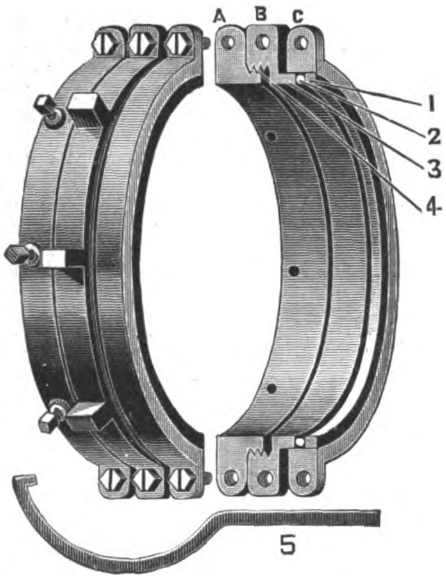
POCKET LAMP AND BATTERY.

sion, as in oil, alcohol or malt tanks, where there is escaping gas, etc.

When used a contact ring is thrown over in contact with the brass band shown, which closes the circuit. The lamp, which is made by James S. Barron & Co., 24 Hudson Street, New York, can be carried in the pocket without danger from chemicals leaking.

STEAM JOINT CLAMP.

The value of a device that will enable a serious leak to be stopped without shutting down a plant or taking down pipes, will be at once evident to the engineer. The clamp shown in the cut herewith has been designed for this purpose, and consists of three separate parts. A rigid clamp, A, with a male thread, is held firmly to the pipe by set screws; a loose clamp, C, which holds the packing and the follower ring; a loose clamp, B, with a female thread and lugs for spanner, which, when screwed away from A, forces with its blank face the packing into the clamp, C, thus making a joint. In the cut packing is designated by 1, the follower by 2, the blank face, B, by 3, and the male and female threads in A and B by 4. As the clamps are made in halves and held together by set screws they can easily be attached to a pipe, and the pipe covering can be replaced over the clamp. The manufacturers, James McCrea & Company, 16 South Canal Street, Chicago, state that a clamp can be attached to a pipe with steam on, in a few minutes.



SECTIONAL CLAMP FOR STEAM JOINTS.

NEW BOOKS.

The Metric System. Hartford: The Hartford Steam Boiler Inspection & Insurance Company. Price, $1.25.

This book was published with a view to facilitating comparisons between the units of the metric system of weights and measures and those of the English and American systems. The book contains an interesting prologue giving a brief history of the metric system, an explanation of the units of the metric and other systems, and a very comprehensive array of tables, giving the equivalent in each system of the units of the other, reductions of values from 1 to 100 in each system to equivalent values in the other system, etc., etc. The tables include linear, square and cubic measures; liquid, dry and energy measures and temperature scales. The volume is of convenient pocket size—3¼ ins. x 5¾ ins.—and substantially bound in red sheepskin.

PERSONALS.

MR. H. L. SHIPPEY, manager of the John A. Roebling's Sons Company, has just returned from a visit to Europe, much refreshed from a sojourn there of several months. Mr. Shippey is a firm believer in the physical benefit of travel, and in various trips has visited most of the places of interest throughout the world.

MR. H. E. RAYMOND, formerly in charge of the polyphase power and transmission plant at Taftville, Conn., has accepted a position from the General Electric Company as its representative at Kingston, Jamaica. Mr. Raymond is one of the few engineers who have had an extended practical experience in the operation of the polyphase system, and in addition is well versed in all of the branches of electrical engineering.

MR. HENRY FLOY and Prof. R. C. Carpenter, of Cornell University, have entered into a partnership as consulting engineers, with offices in the St. Paul Building, New York. Mr. Floy is well known as one of the leading electrical engineers of the country, having occupied a prominent position in that capacity with the Westinghouse Company for a number of years, while Prof. Carpenter has an international reputation as a mechanical engineer. The combination is thus one of unusual strength, and will undoubtedly occupy a very prominent position in the engineering field.

MR. W. HEATHCOTE, engineer of the Replogle Governor Works, at Akron, Ohio, called at the Chicago office of the "American Electrician" while en route to Los Angeles to install a new type of the Replogle governors which are to be used in the Southern California Power Company's plant. Mr. Heathcote reports that his company has been compelled to run overtime for some weeks past in order to keep up with their trade. This company has just shipped large orders of governors to Finland, Italy, Japan, Russia and other foreign countries, which shows the appreciation of engineers in every part of the globe for first-class American apparatus.

TRADE PUBLICATIONS.

DYNAMO BRUSHES. — Non-sparking brushes are fully described in a bulletin that is being distributed by the Western Electric Company, of Chicago and New York.

FEED WATER HEATER.—A handsome wall hanger in three colors is sent us by the Robertson Manufacturing Company, 204 Fulton Street, New York, which very clearly illustrates in three colors the "New World" return copper coil feed water heater.

STORAGE BATTERIES.—The storage battery auxiliary plant of the Commercial Cable Building is described in a circular issued by the Electric Storage Battery Company, Drexel Building, Philadelphia, Pa. Excellent views of the plant are given, and also a diagram showing curves of the regulating effect of storage batteries in isolated plants for office buildings.

THE PATTERSON, GOTTFRIED & HUNTER COMPANY, Limited, New York, has issued a little catalogue which will be of interest to everybody that has to do with machine tools, in which are described engine lathes, turret lathes, sharpers, power presses, milling and grinding machinery. These tools are thoroughly described and illustrated, and dimensional tables are given concerning them.

STEAM SEPARATORS AND OIL ELIMINATORS.—Numerous types of Hoppes separators are illustrated and described in a well-executed catalogue issued by the Hoppes Manufacturing Company, of Springfield, O. These separators are made in vertical and horizontal forms, and for all classes of service. The company calls attention, in a folder accompanying the book, to some exceptionally strong testimonials.

ELEVATING AND CONVEYING MACHINERY.—In a 136-page catalogue, the Aultman Company, of Canton, Ohio, describe their various manufactures, consisting of elevating and conveying machinery, labor-saving appliances, power transmission machinery, sprocket wheels, chains, gears, pulleys, etc. A considerable section of the book is devoted to elevating and conveying machinery, many types of which are well illustrated.

STEAM REGULATING DEVICES AND STEAM PUMPS.—With this title the Mason Regulator Company, 6 Oliver Street, Boston, Mass., have issued a pamphlet containing descriptions of the various Mason apparatus. The descriptions are thorough and clear, in both these respects being above the average of similar matter in trade publications. In fact, as a descriptive treatise on steam appliances, this little pamphlet might be employed with profit as a text-book for engineering students.

PUSH BUTTON SWITCHES.—In an artistically gotten up leaflet the Anchor Electric Company, 71 Federal Street, Boston, illustrates and describes its latest type of push button switch, and also the Anchor snap switch and the Anchor plugs and receptacles, the latter being designed to be placed at several points in a room without disfiguring the walls or floor, and are at all times available for attaching a cord for a lamp for the piano, dining or parlor table, or when a temporary lamp is needed.

POWER PUMPS. — "Efficient Power Pumps" is the title of a handsome new catalogue issued by the Goulds Manufacturing Company, Seneca Falls, N. Y. The catalogue contains, besides illustrations and descriptions of a most comprehensive line of power pumps, triplex and other types, a quantity of valuable information concerning the general operation of pumps, the capacity of pipes and cylinders, friction of water in pipes, etc., which is not usually found outside of the standard engineers' reference books.

A STEAM ENGINE INDICATOR can be built for $2.50, it is stated, by following the instructions and working drawings contained in a new book entitled "How to Build an Indicator," written by A. C. Lippincott and published by the New York Publishing and Model Company, No. 1 Cortlandt Street, New York. That is to say, the materials necessary to the construction of the indicator described in the book may be obtained for $2.50, the labor, of course, not being counted as an item of expense. The price of the book in paper covers is 50 cents; in cloth binding, 75 cents.

A MONTHLY TELEPHONE BULLETIN.—A telephone bulletin, issued on the 15th of each month, has just been inaugurated by the Farr Telephone & Construction Supply Company, of 357 Dearborn Street, Chicago. The first issue of the Bulletin, dated October 15, shows a number of telephones, parts, auxiliary appliances, batteries, etc., which the Farr Company is offering to the trade. The price of each instrument, battery and appurtenance is given also. Although a diversity of styles is shown by the illustrations, the company states positively that none of its products infringe the patent rights of any other manufacturer.

ELECTRICAL MEASURING INSTRUMENTS.—Under this title an attractive catalogue has just been issued by James G. Biddle, of Philadelphia, Pa. The catalogue, which is known as Catalogue B, contains descriptions and illustrations of an extensive line of high-grade laboratory and portable testing instruments of English and American manufacture. Among the makers represented by Mr. Biddle are James White, Glasgow; Elliott Brothers, London; Societé Genevoise, Geneva; the Weston Electrical Instrument Company, Newark, N. J., and Elmer G. Willyoung & Company, Philadelphia, all of whom are well known to the trade as producers of standard measuring instruments and accessories.

THE B. F. STURTEVANT COMPANY, of Boston, Mass., has contributed two catalogues to trade literature which are very interesting. The first, a book of 24 pages, describes its blowers, heaters and ventilating apparatus, and is well illustrated. The second booklet is devoted to the subject of mechanical draft, and its application to the B. F. Sturtevant Company's works. The company states in its catalogue that the addition of the blower has enabled the use of yard screenings costing $2.00 per ton, where heretofore it was necessary to burn Cumberland coal costing $3.65 per ton. The use of mechanical draft in its own plant has enabled the company to do away with a tall brick chimney, which is replaced by a small smokestack, extending only 31 ft. above the boiler room floor.

ELECTRICAL DECORATIONS.—The pioneer in the line of electrical decorative work, the Edison Decorative and Miniature Lamp Department (General Electric Company), Harrison, N. J., is still maintaining the enviable reputation that it long ago established on its extensive line of made-up electrically illuminated devices for show window displays, or for use outdoors for decorative illuminations. These devices are especially in demand for holiday decorations, and have been successfully exhibited in many parts of the country. Their system of renting these devices enables handsome displays to be made at a price vastly below what it would cost to build the same decorations specially for one occasion. This department publishes an illustrated catalogue of decorative devices, in which the fullest details are given as to the sizes and weights of the various pieces, as well as the current consumption, number of lamps, etc. The department also publishes a handsome catalogue of candelabra, series, decorative and other miniature lamps and receptacles, and carries so extensive a line of these goods as to be able to ship many thousands of its standard products at a few hours' notice.

BUSINESS NEWS.

M. DAVIS & SONS, Salem, Ohio, is the style of a new electrical manufacturing firm who have put on the market, among other things, a new switch cut-out and an improved arc lamp mast arm for street service.

THE OTTO GAS ENGINE WORKS, Philadelphia, state that they have been awarded the gold medal at the Omaha Exposition in competition with a number of different makes of gasoline engines.

THE YORKVILLE ELECTRIC CONSTRUCTING COMPANY is a new firm which has just established its offices at 23 Barclay Street, New York City, and is prepared to do a general electrical supply and construction business.

THE G. & E. ELECTRIC COMPANY, Binghamton, N. Y., successors of the Columbia Mfg. Company, of the same city, are manufacturers of dynamos, motors, direct connected elevators, for passenger and freight service; also of the Climax water motor and the G. & E. boring machine.

THE LAVARITE MANUFACTURING COMPANY, New York, is putting on the market a compound for coloring and frosting electric lamp globes, which is claimed to be unusually durable and effective and can be furnished at a very moderate cost. The company's offices are at 21 and 23 Ann Street.

A FOUR-STORY ADDITION, 50 ft. x 120 ft., to its factory is being erected by the Phillips Insulated Wire Company, of Pawtucket, R. I., as well as a one-story annex, 65 ft. x 120 ft., these extensions being rendered necessary to provide facilities adequate to the increase in business enjoyed by the company.

PATRIOTIC DESIGNS IN LAMP SHADES have been perfected by the Phoenix Glass Company, of Pittsburgh and New York City, which include likenesses of Admirals Dewey, Sampson and Schley, etched in the glass. These are made for incandescent lamps, gas fixtures, etc.

THE CHICAGO EDISON COMPANY, 139 Adams Street, Chicago, is offering some bargains in second-hand machinery. This apparatus has been taken from the company's own plants, being displaced by apparatus of greater capacity, and not, it is stated, because of any defect or lack of satisfactory service.

WILLIAM ROCHE, New York City, reports that his new 7 in. x. 3 in. battery cell for gas engine work is meeting with great success in the trade. The cell has been tested by prominent gas engine builders with very good results. Physicians find this an excellent cell for cautery work, where it gives satisfactory results.

THE HARRISBURG FOUNDRY AND MACHINE WORKS, Harrisburg, Pa., is about to let a contract for the erection of a two-story brick and stone building, with ground dimensions of 260 ft. x 140 ft. At present this firm has unfilled orders for more than forty engines, and an increase of facilities has become a necessity.

MR. SEATON M. SCOTT, consulting engineer, with offices at 11 Broadway, New York City, is prepared to make plans and specifications for electric lighting stations and street railway plants, and to supervise the construction of such plants. Mr. Scott also announces that he is prepared to furnish designs for special machinery, and, if desired, to supervise the construction of such machinery.

THE MUELLER ELECTRIC COMPANY has just been organized by Messrs. William Mueller and H. J. Schuette, with headquarters at 713-715 Burling Street, Chicago, Ill. Mr. Mueller, who is already well known in the electrical trades, assures his customers that their orders will receive prompt attention, as the new company has an experienced corps of employees. The Mueller Electric Company has issued a new catalogue of its specialties.

WIRT RHEOSTATS, manufactured by Charles Wirt, of 1028 Filbert Street, Philadelphia, Pa., are in such demand, it is reported, as to necessitate an extension of the manufacturer's floor space and facilities. A feature to which is attributed much of the success of these rheostats is the close graduation obtained by providing an unusually great number of divisions, which is rendered practical by the peculiar construction of the rheostat.

AN EASTERN OFFICE has been established at 205 Postal Telegraph Building, New York City, by the Simplex Telephone Company, of Cincinnati, manufacturer of interior telephones. This office will be in charge of E. L. Harper & Son, who will spare no effort to duplicate in their territory the success attained by the Simplex instruments in the installations already made in the West and elsewhere.

A NEW BATTERY MOTOR has been brought out by the Porter Standard Motor Company, of Lebanon, N. H. It is known as Porter Motor No. 7, and possesses the unusual feature of a six-coil armature and a field magnet similar in type to larger motors designed for use on power circuits. The machine is symmetrical and substantial in appearance and is said to be highly efficient. It requires two cells of the new compound Fuller battery, or any other good type, to operate it.

THAT SOFT COAL can now be burned by the use of suitable stokers without smoking or soot is likely to bring considerable business to the American Stoker Company, of New York City, which has been remarkably successful in its new stoker, as it performs the office of promoting smokeless combustion to perfection. As soon as the public finds that the smoke nuisance can be abated, the ordinances against it will undoubtedly be still more stringently enforced.

THE STEWART ELECTRICAL COMPANY, Cincinnati, Ohio, has been reorganized and is now under the management and proprietorship of Mr. E. W. Mullikin, lately President of the American Laundry Machine Company, and now Treasurer of Campbell Manufacturing Company, of Cincinnati. Mr. Mullikin brings into the company ample capital and a large business experience. Mr. John A. Stewart remains with the company, which bears his name. He is too well known to the electrical trade to need introduction.

ENCLOSED ARC LAMPS appear to be steadily gaining ground, judging from the installations reported by the General Electric Company, among which are 700 lamps placed on alternating current circuits by the Edison Lighting Company, St. Louis; 130 lamps put in store of the May Shoe and Clothing Company, Denver, and 200 lamps installed in the store of Boggs & Buhl, Allegheny, Pa. The lamps put in by the St. Louis Edison Company were of the single globe type and those used by the Allegheny establishment are of the double globe type.

I-T-E CIRCUIT-BREAKERS, manufactured by the Cutter Electrical & Manufacturing Company, of 1112 Sansom Street, Philadelphia, are in successful operation in all parts of the world. This company makes a large variety of circuit breakers, a type being made to apply to every case requiring such a piece of apparatus. It is stated that the greatest possible care is exercised in the manufacture of the I-T-E circuit-breakers, both as to materials and workmanship, no expense or labor being spared to make them everything that they should be.

THE ELECTRIC APPLIANCE COMPANY, Chicago, states that arrangements have been consummated whereby it will carry a large stock of magnet wire of Eastern manufacture, in addition to its stock of line and other wires so that users of magnet wires may rely upon having their orders promptly filled. The company also states that its combination fuse-block and lightning arrester for telephone circuits is meeting with conspicuous success. For heavy duty circuits the company furnishes Wurts arresters, of the merits of which everyone knows.

AMERICAN INCLOSED ARC LAMP.—Chas. J. Bogue, 213 Centre Street, New York, who is placing the Hero American inclosed arc lamp on the market, is one of the oldest electricians in the city, and has had over eighteen years' practical experience in lamp construction work. As is well known, Mr. Bogue also manufactures all kinds of electrical goods, comprising armatures, commutators, dynamos, motors, etc. His name is well known to all dealers and users of electrical goods, and he and his manufactures have earned a high reputation from the quality of the work and materials put in them.

STANDARD PAINT COMPANY IN EUROPE.—A European factory was recently established at Hamburg, Germany, by the Standard Paint Company, 81 John Street, New York, manufacturers of the widely known and as widely used "P. & B." compounds, tapes, etc. This step, it is stated, was rendered necessary by reason of the greatly increased volume of foreign business which has come to the company. The German factory will produce exactly the same line and quality of goods that have made the reputation of the "P. & B." products turned out by the American establishment.

GOOD TELEPHONES AT LOW COST are what the Eastern Telephone Mfg. Company, of Meriden, Conn., states it is making. It is explained that this company's instruments are made in very large quantities and all parts are thoroughly standardized, so that special fitting, winding, or other features are unnecessary; furthermore, the company has no travelling representatives and sells for cash only. These details combine to greatly reduce the cost at which reliable instruments can be produced, it is stated, and enable this company to offer inducements to prospective telephone buyers.

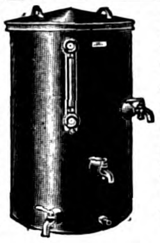
THE MOGADORE INSULATOR COMPANY, Mogadore, Ohio, which succeeded the J. S. Monroe Pottery Company, announces that it is in position to furnish promptly all forms of porcelain and clay work used by electrical engineers, such as wiring tubes, knobs, cleats, etc., and is also well equipped for turning out special work to order. In taking over the business of the J. S. Monroe Pottery Company, Messrs. J. A. Dixon and I. M. Martin succeeded Messrs. J. S. and E. D. Monroe. Mr. G. A. Monroe retains the same interest in the new concern that he held in the old one.

THE CLEVELAND ELECTRIC TRADING COMPANY, 806 Cuyahoga Building, Cleveland, Ohio, reports a very prosperous fall trade, in both new and second-hand apparatus. The shipments of machinery have extended from Connecticut to California, and from Northern Minnesota to Texas. This company handles second-hand goods of high grade, either on consignment or by direct purchase, as desired, and is selling agent for some very good lines of supplies and machinery. The company is now arranging to increase its facilities for handling work, both in repairs and second-hand goods, and hopes to enter upon the new year with a factory of its own which will be well equipped for handling all classes of electrical work.

THE LARGEST SALE OF BOILERS ever made is a feat claimed by the Stirling Company, of New York and Chicago. The sale referred to is one recently made to the Cramp ship-building establishment, at Philadelphia, the contract calling for 40,000 h.p. of water-tube boilers of the Niclausse type. The Stirling Company has acquired the exclusive right to manufacture this type of boiler in America, as well as similar rights for the Yarrow and Mosher types, all of which were recently tested under conditions of actual naval service in the Hispano-American war. The shops of the Stirling Company, which were extended last spring to provide for increasing business, have become inadequate to the company's needs, and it is stated that ground will be broken soon for another large addition to the works.

THE THERMOSTATIC FIRE ALARM CABLE, manufactured by the Montauk Multiphase Cable Company, of 100 Broadway, New York, is attracting attention at the Twentieth Triennial Exhibition of the Massachusetts Charitable Mechanic Association, now being held in Boston. The cable is thermostatic at every point of its length, and reports of tests made at St. Louis, Mo., and at Melbourne, Australia, recently, state that it is entirely effective. The St. Louis report states that "the flame of a match will set it off anywhere," and the Melbourne rereport states that "when a flame was applied to the covered cable for a few seconds it was at once set in motion and registered a prearranged signal at Bouverie Street." The report continues: "The experiments were an unqualified success."

THE EMERSON ELECTRIC MFG. COMPANY, of St. Louis, Mo., has recently completed and is ready to furnish a device by



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actually reduces oil bills 50 per cent. or more. Sent on approval. Capacities ranging from 3 to 120 gals. per day. Used in 18 countries. It is specially adapted to Electric Light and Power Plants. Established 8 successful years.
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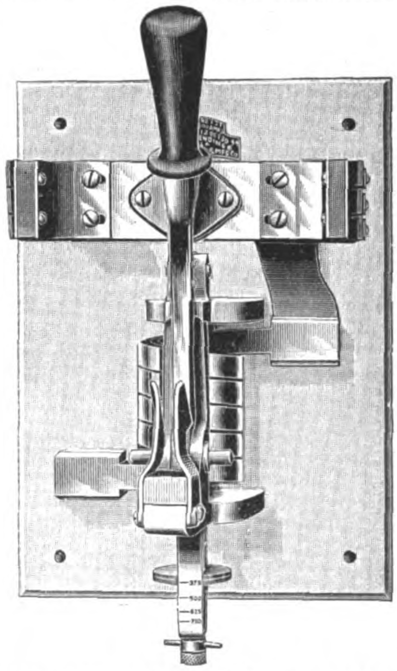

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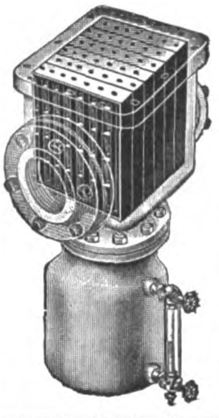

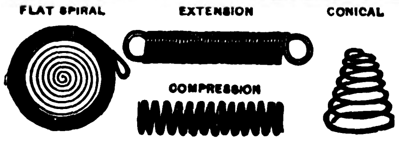

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We will send you a Sample Can and guarantee that the belts will stop slipping; the power shall be **permanently** increased; the belt can be run slack, and the leather shall become as soft as calfskin; also absolutely waterproof.
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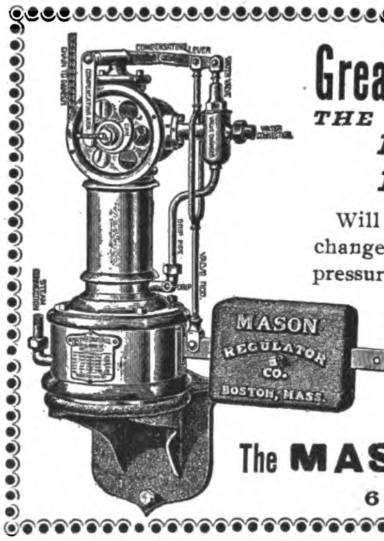
means of which large church organs can be operated satisfactorily with the use of alternating current motors. This special adaptation of alternating current motors has been worked up in response to numerous inquiries extending over a number of years, and they believe that it is the only device on the market by which churches, placed beyond the reach of direct current, can operate their orban bellows with an electric motor. Printed matter describing this device is now in course of preparation, and will be ready for distribution to interested parties within a short time. In the meantime the Emerson Company would be glad to receive inquiries from interested parties to whom they will send blue print and give all information.

THE WARREN ELEC. MFG. COMPANY of Sandusky, Ohio, have just closed a contract with Armour & Company, Chicago, for one 7000-light, 350-k.w. Warren alternator of 7200 alternations and 360 r.p.m, and two 3600-light alternations and 360 r.p.m., and two 3600-light 600 r.p.m. These machines are to be installed in the new central station which is being erected by Armour & Company at the Stock Yards, Chicago. The Warren Electric Manufacturing Company are to be congratulated over this large order, as the competition was very fierce. The record, however, that the Warren apparatus has made in the past proved a sufficient guarantee to Armour & Company, and they feel assured that they have secured the best on the market. This contract was closed by Mr. J. Holt Gates, the Chicago representative of the Warren Company.

A NEW TYPE OF SHADE HOLDER, known as the "Ideal," has been brought out by the Central Electric Company, of Chicago. The holder is made of a single piece of metal and said to be so constructed as to prevent its getting out of shape under ordinary usage. The company recently moved into a suite of handsome offices located at 264-270 Fifth Avenue, where more room is afforded for the extensive stock of goods carried by this company than at the old headquarters. The company is preparing to carry a most complete line of portable table and desk lamps and has put in a large stock of miniature incandescent lamps in anticipation of the Christmas holiday trade. These lamps are furnished in clear and natural colors, and of all candle-powers and voltages. A new type of miniature lamp has been brought out which is adapted for use in a standard socket, and is obtainable in voltages from 90 to 125 inclusive. The small dimensions of this lamp and its standard base make it particularly convenient for use in electric sign and decorative work.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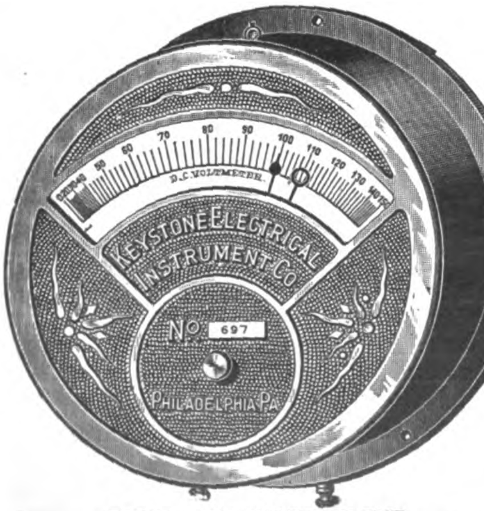
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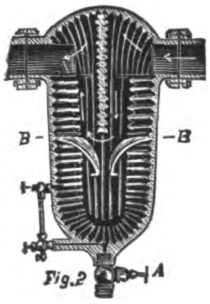

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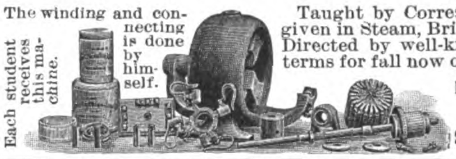

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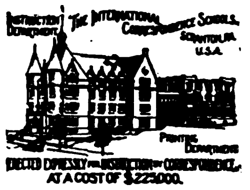
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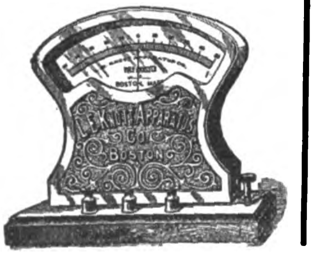
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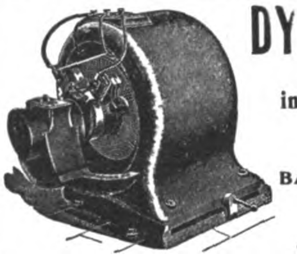

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A T.-H. MD2 Arc Dynamo, thoroughly overhauled, fully warranted, ring armature rewound, complete with instruments,	$480.00
A 65-light, 2,000 c.p. Brush Arc Dynamo, nearly new, self-oiling, with instruments,	525.00
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A 750-light Westinghouse Alternator, complete as above, armature rewound,	475.00
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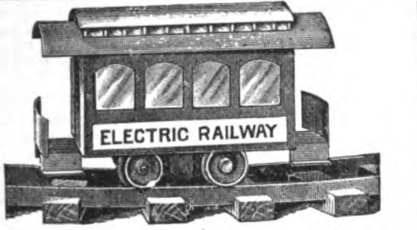

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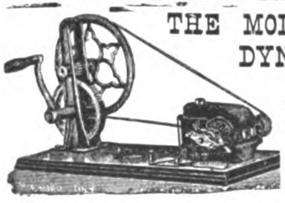

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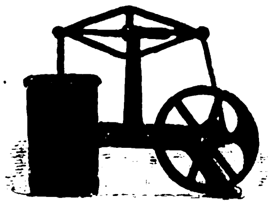

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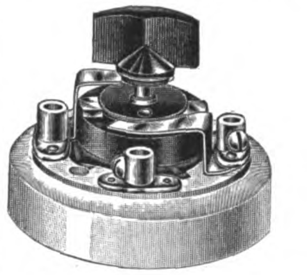

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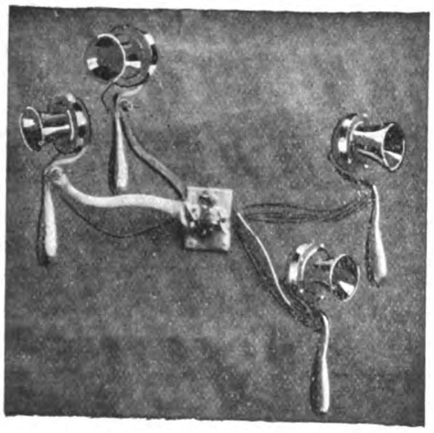

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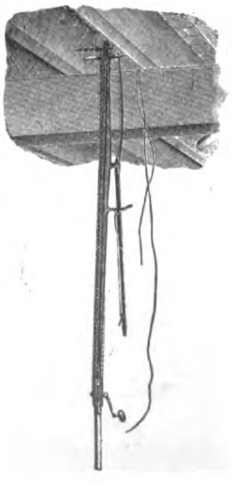

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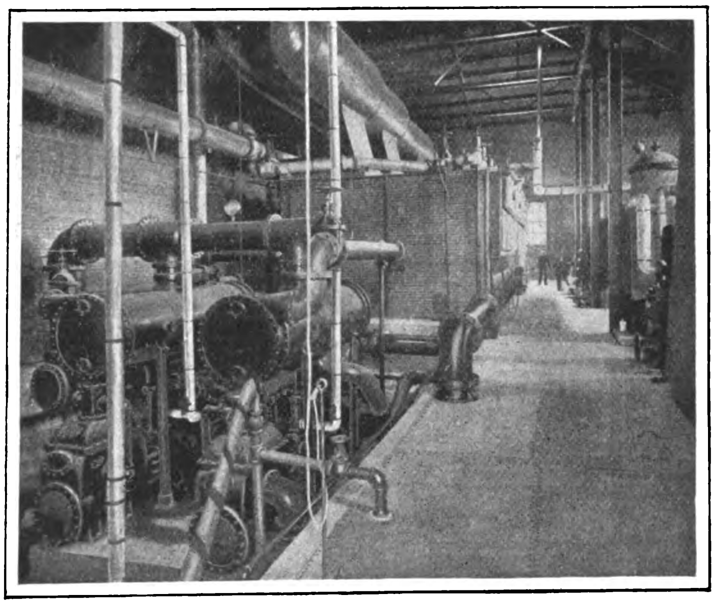

The Condensing Apparatus shown in the above illustration was installed by us in the Power House of the Colorado Electric Power Company's Plant at Cañon City, Colo., described on page 527.

* * * *

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HAMILTON CORLISS ENGINES

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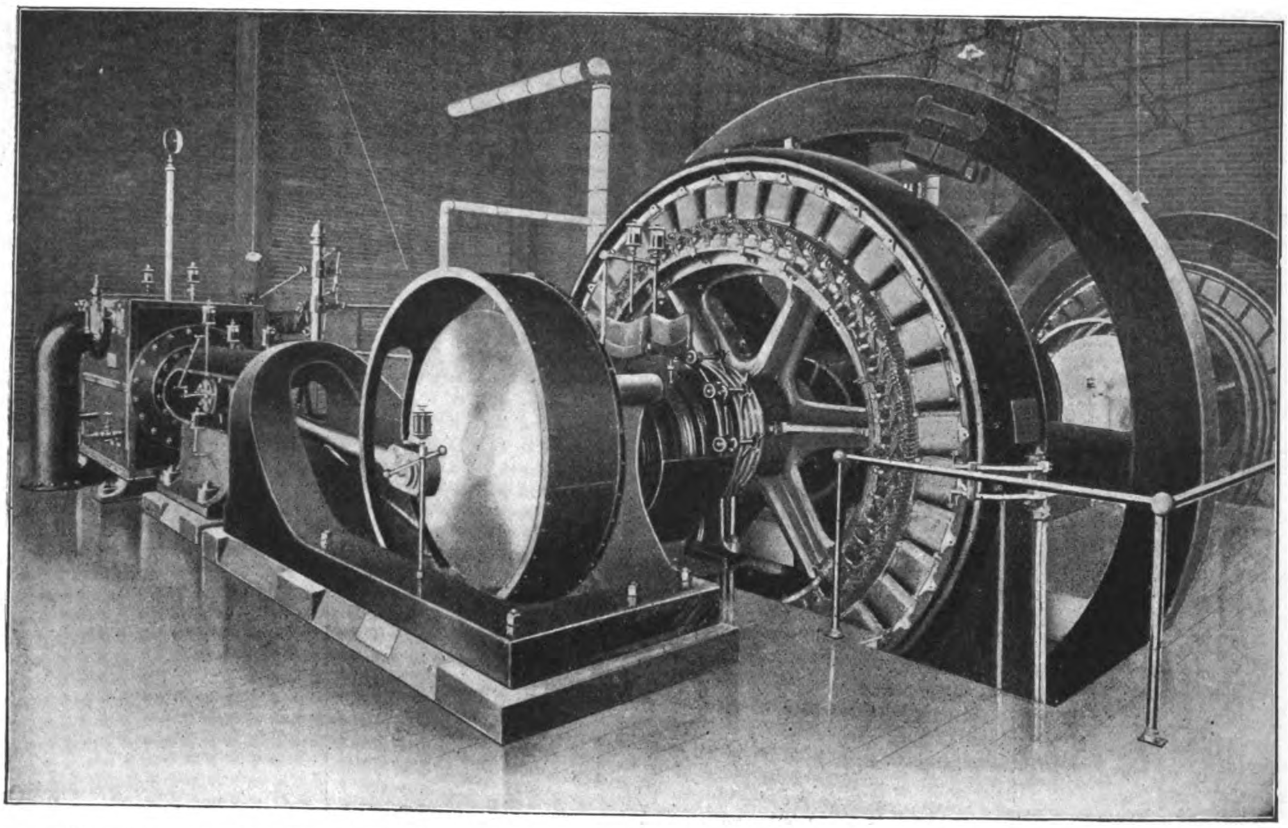

The above illustration shows a 700 H. P. Hamilton Corliss Engine direct connected to a Westinghouse Generator in the Electric Transmission Plant of the Colorado Electric Power Company, of Cañon City, Colo. See description on page 527.

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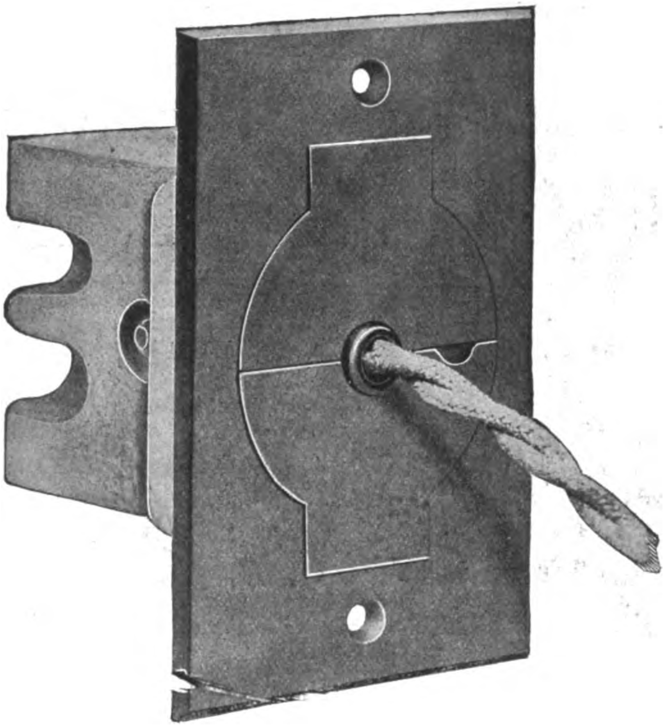

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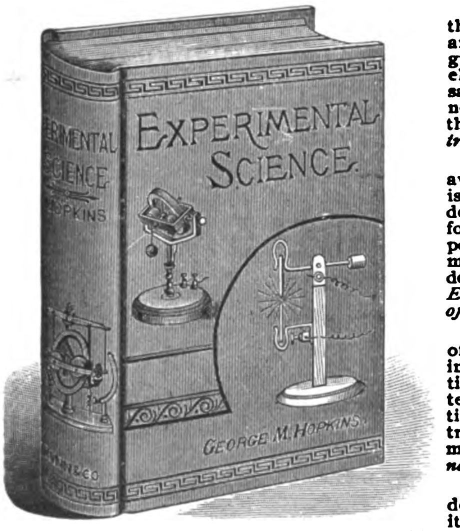

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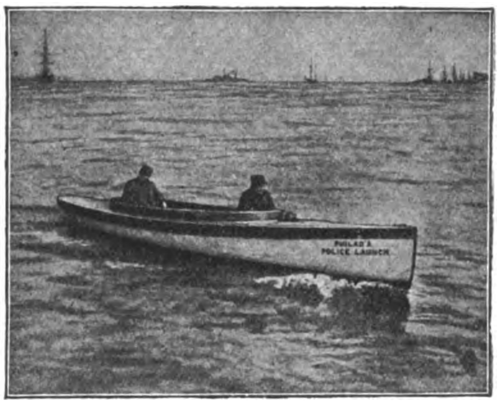

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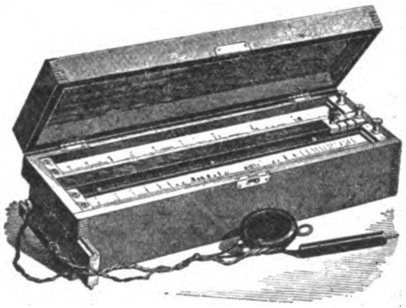

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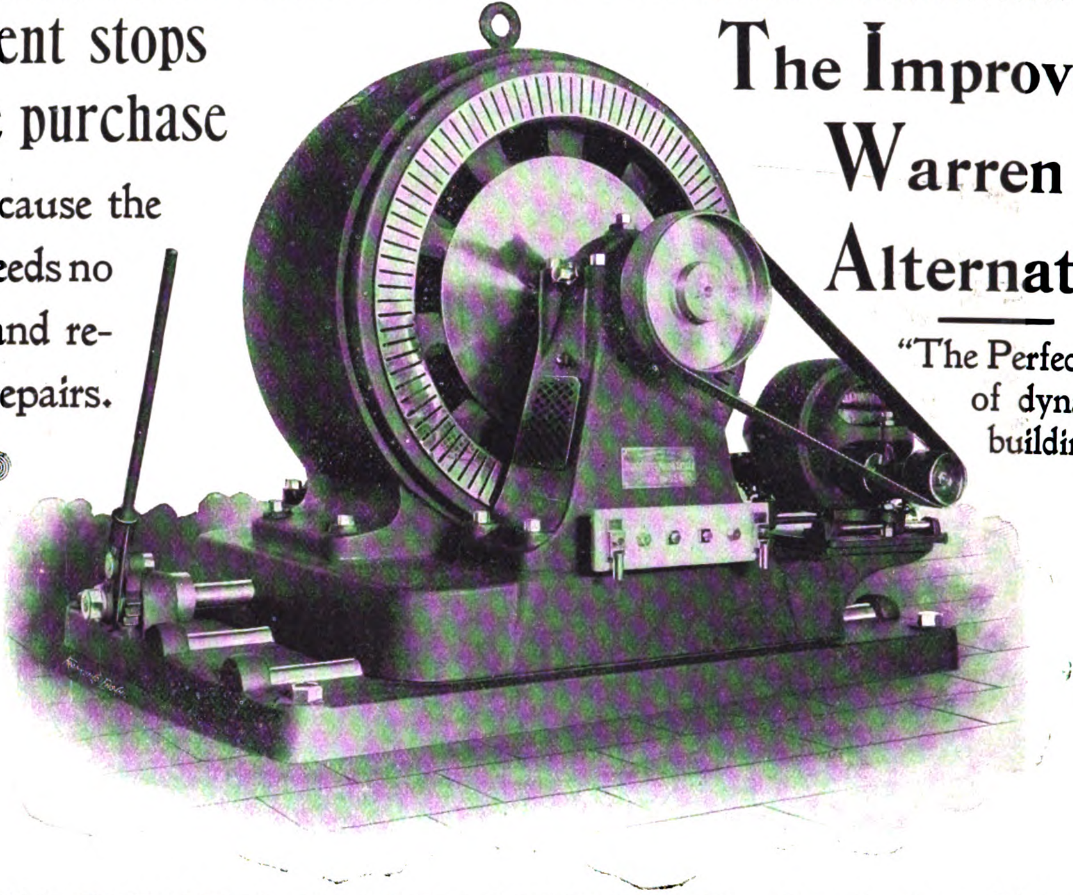

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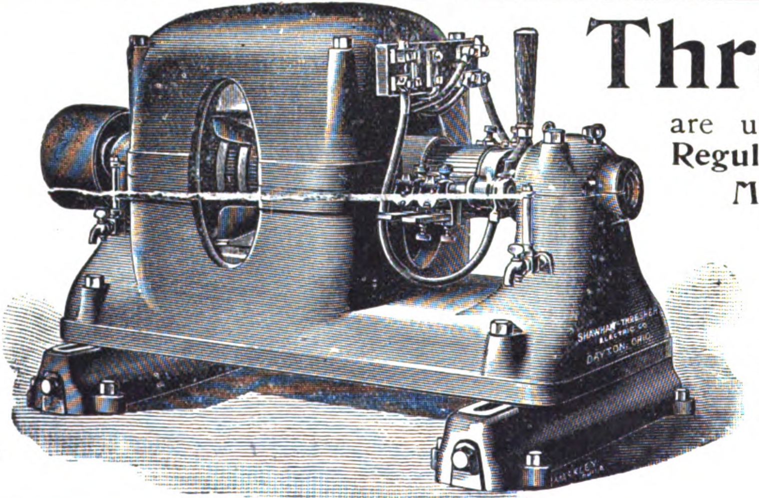

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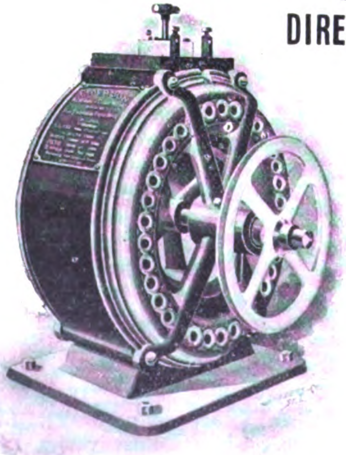

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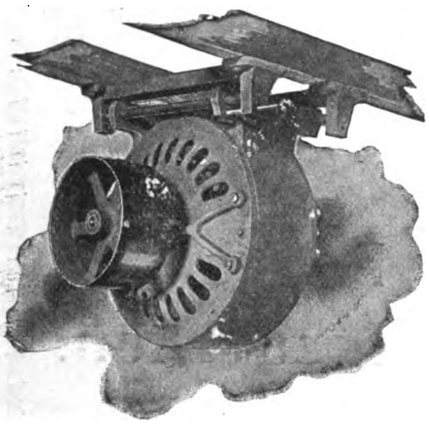

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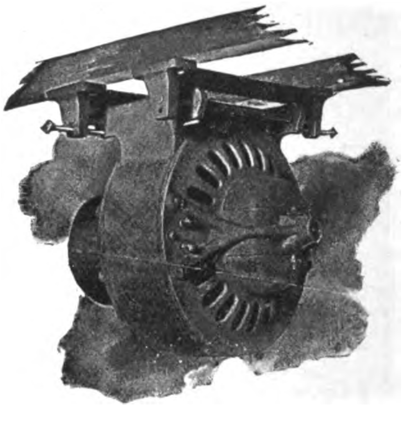

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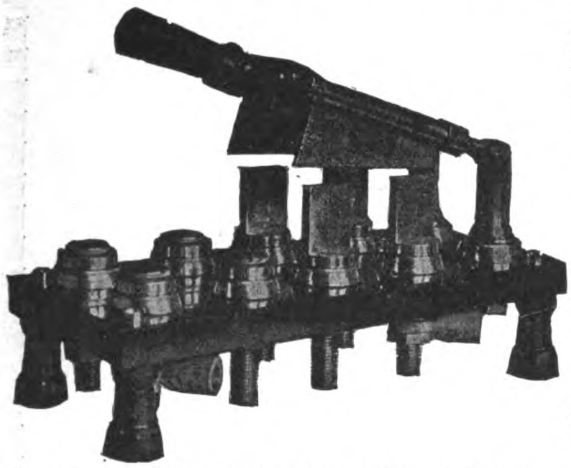

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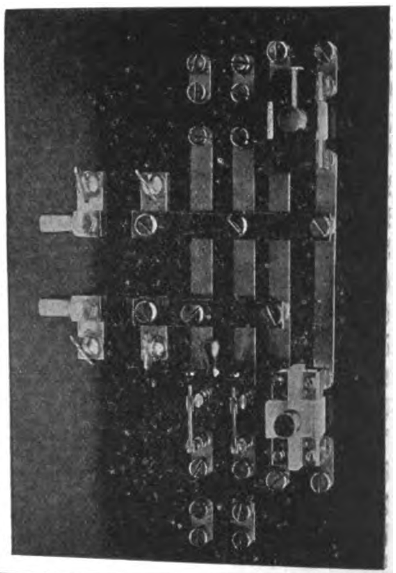

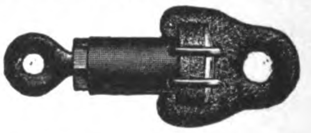

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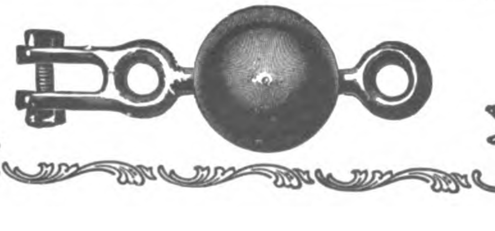

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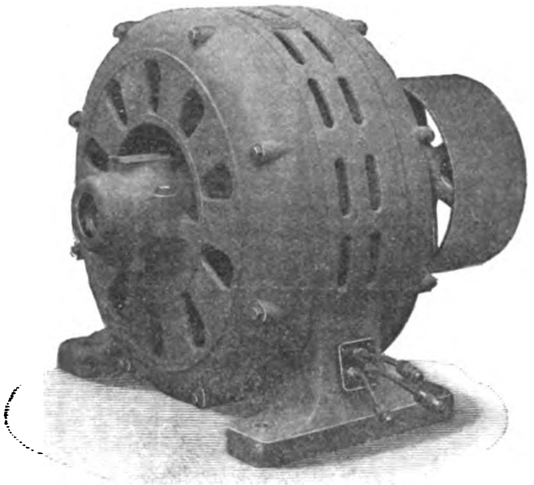

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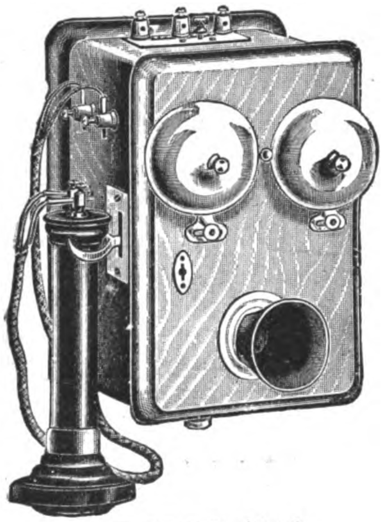

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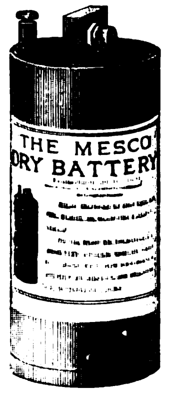

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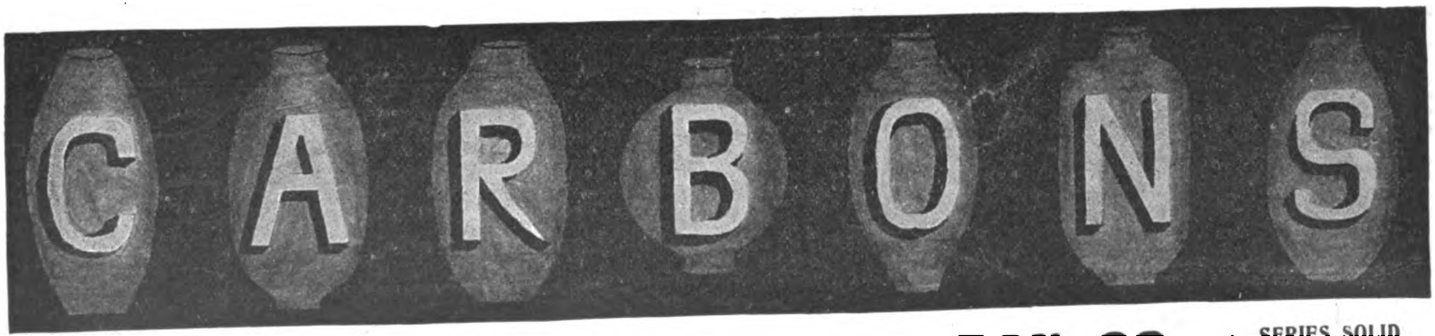

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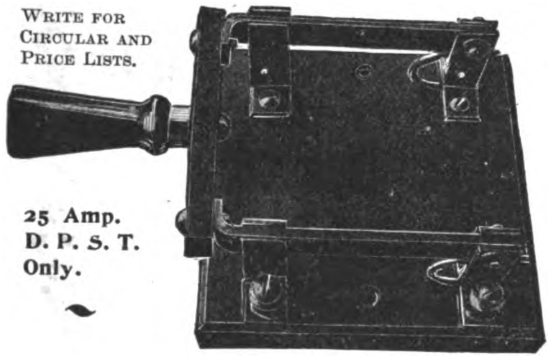

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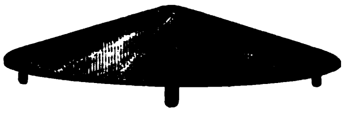

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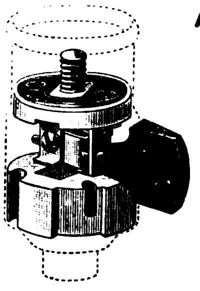

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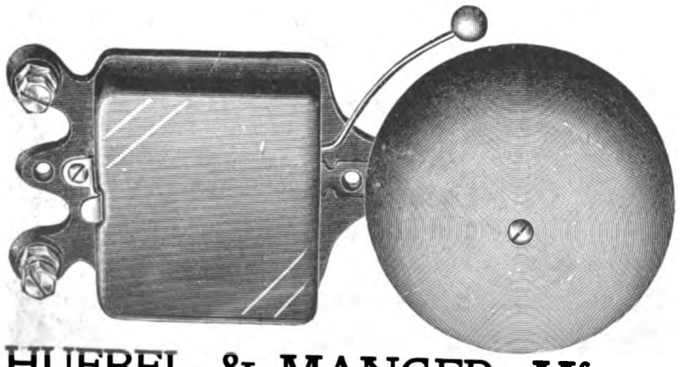

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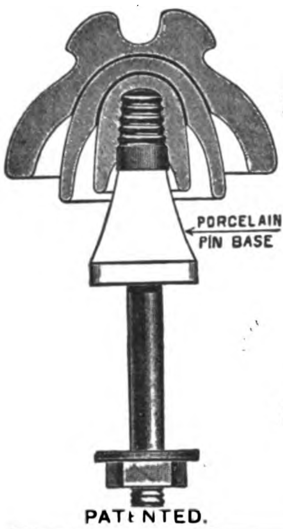

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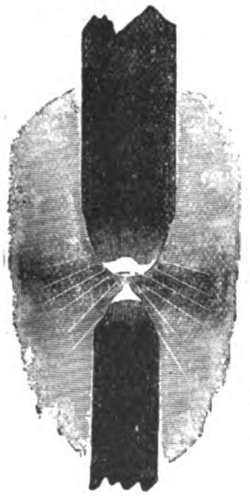

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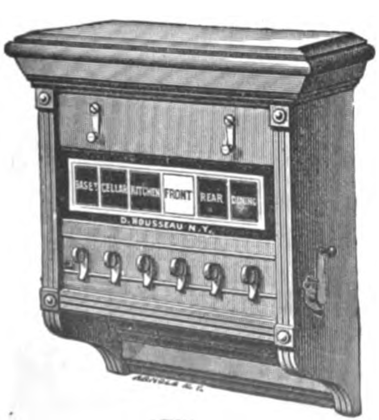

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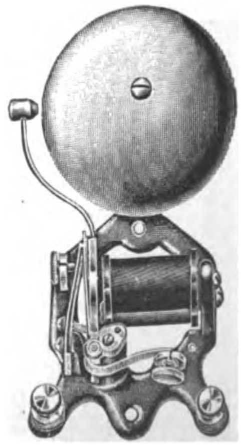

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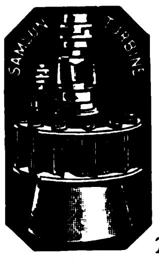

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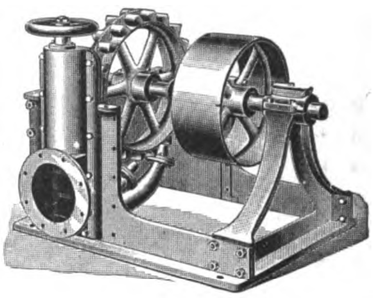

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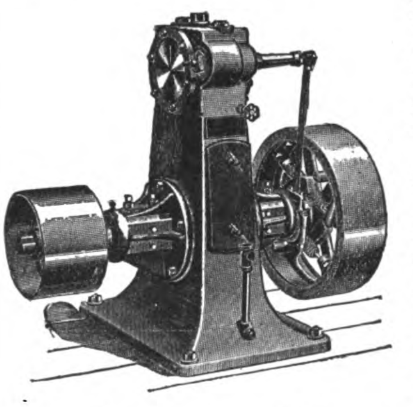

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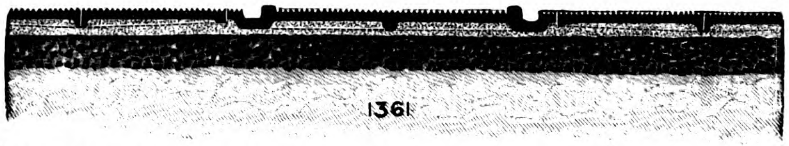

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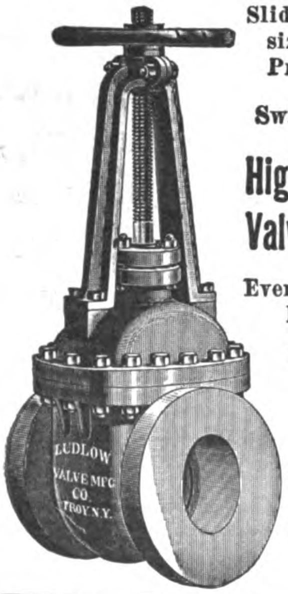

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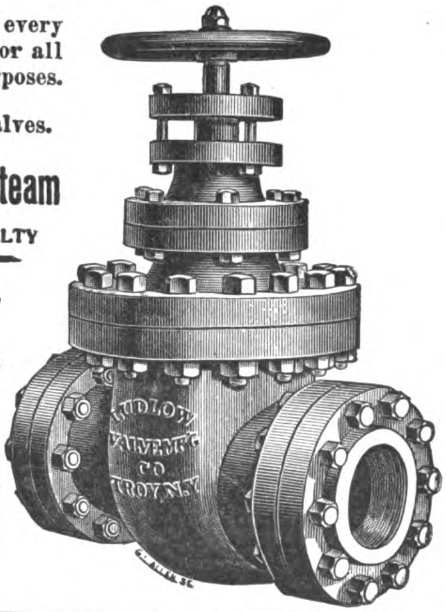

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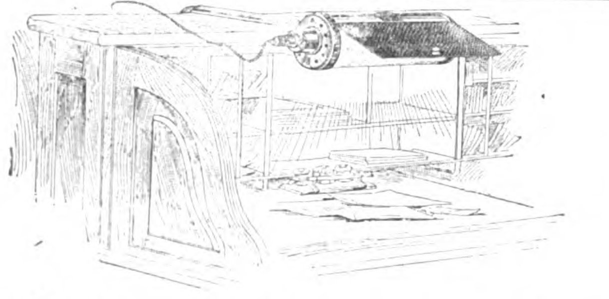

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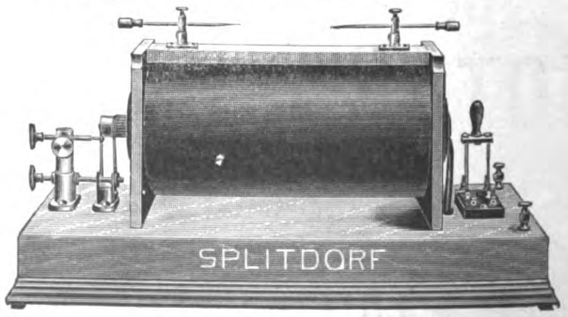

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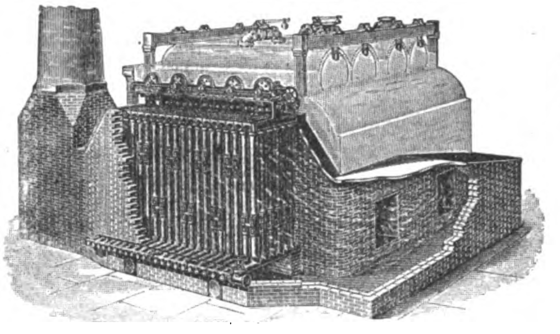

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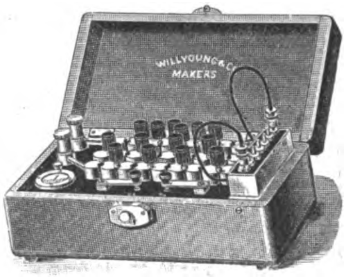

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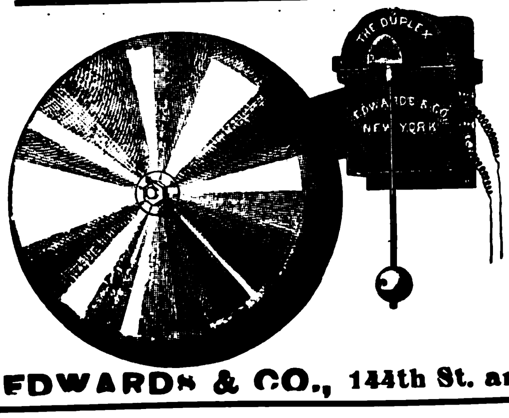

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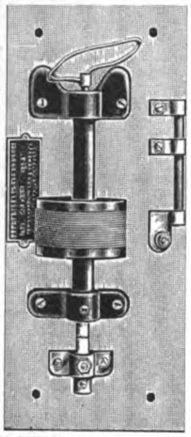

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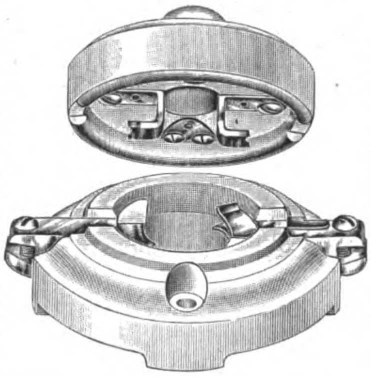

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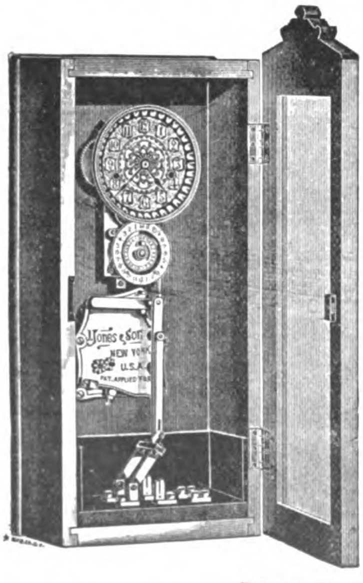

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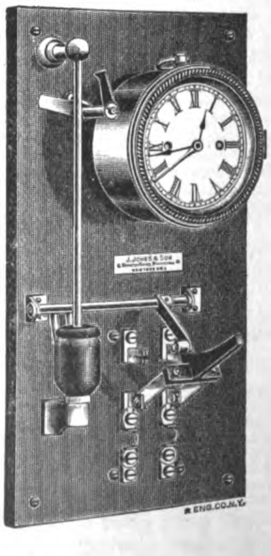

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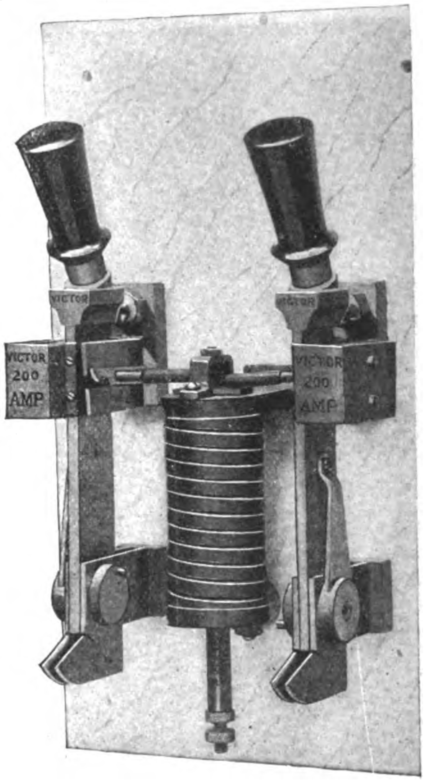

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Electric Appliance Co., Chicago, Ill.
Frink, I. P., New York.
McCreary, A. A., New York.
Phoenix Glass Co., Pittsburgh and New York.
Wheeler Reflector Co., Boston, Mass.

REGULATORS (Damper, Pressure, Etc.)

Mason Regulator Co., Boston, Mass.

REPAIRING (ELECTRICAL).

Cass & Aaron, Chicago.
Chicago Armature Co., Chicago, Ill.
Elliott Elec. Co., Cleveland.
Lincoln Electric Co., Cleveland, O.
Miller-Knoblock Co., South Bend, Ind.
Stewart Elec. Co., Cincinnati, O.

RHEOSTATS.

Cutler-Hammer Mfg. Co., Chicago.
Ohio Electric Specialty Mfg. Co., Troy, O.
Wirt, Chas., Philadelphia.

SECOND-HAND APPARATUS.

Cass & Aaron, Chicago.
Chicago Edison Co., Chicago.
Cleveland Elec. Trading Co., Cleveland, O.
Elliott Elec. Co., Cleveland.
Lincoln Electric Co., Cleveland, O.
Stewart Elec. Co., Cincinnati, O.

SEPARATORS, STEAM AND GREASE.

Goubert Manufacturing Co., New York.
Hoppes Mfg. Co., Springfield, O.
Westinghouse, Church, Kerr & Co., New York.

SOCKETS.

Paiste, H. T., Co., Chicago, Philadelphia.
Pass & Seymour, Syracuse, N. Y.
Zimdars & Hunt, New York.

SPRINGS.

Cary Spring Works, New York.

STOKERS.

American Stoker Co., New York, N. Y.
Westinghouse, Church, Kerr & Co., New York.

SUPPLIES, ELECTRICAL.—(General.)

Bibber-White Co., Boston, Mass.
Central Electric Co., Chicago, Ill.
Cherry Electric Works, New York City.
Commercial Electric Supply Co., St. Louis.
Electric Appliance Co., Chicago, Ill.
Electric Gas Lighting Co., Boston, Mass.
Farr Telephone & Construction Supply Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Heath Electric Co., Detroit, Mich.
Jones, J. & Son, New York.
McIntire Co., The, Newark, N. J.
Mueller Elec. Co., Chicago.
Ohio Electric Works, Cleveland, O.
Partrick, Carter & Wilkins, Philadelphia.
Sterling Supply & Manufacturing Co., New York.

SWITCHES AND SWITCHBOARDS.

Crouse-Hinds Electric Co., Syracuse, N. Y.
Electric Appliance Co., Chicago, Ill.
Emerson Electric Mfg. Co., St. Louis, Mo.
General Electric Co., Schenectady, N. Y.
Hart & Hegeman, Hartford, Conn.
Hill, W. S., Electric Co., New Bedford, Mass.
Huebel & Manger, Brooklyn, N. Y.
Machado & Roller, New York, N. Y.
Paiste, H. T., Chicago, Philadelphia.
Shawmut Fuse Wire Co., Boston.
White, H. P., & Co., Philadelphia, Pa.

TAPES, INSULATING.

Eastern Electric Cable Co., Boston, Mass.
Electric Appliance Co., Chicago, Ill.
Okonite Co., New York.
Standard Underground Cable Co., Pittsburgh, Pa.

TELEGRAPH APPARATUS.

Electric Appliance Co., Chicago, Ill.
Partrick, Carter & Wilkins, Philadelphia.

TELEPHONES.

Allen-Hussey Co., Chicago, Ill.
Central Electric Co., Chicago, Ill.
Central Telephone & Elec. Co., St. Louis.
Conn. Tel. & Electric Co., Meriden, Conn.
De Veau & Co., New York.
Eastern Tel. Mfg. Co., Meriden, Conn.
Electric Appliance Co., Chicago, Ill.
Farr Tel. & Con. Supply Co., Chicago, Ill.
Gordon, A. Y., Massillon, O.
Mianus Electric Co., Mianus, Conn.
New York Tel. Co., New York.
Ohio Electric Works, Cleveland, O.
Reliable Elec. Mfg. Co., Worcester, Mass.
Stromberg-Carlson Telephone Mfg. Co., Chicago, Ill.
Western Telephone Construction Co., Chicago, Ill.

TOOLS.

G. & E. Elec. Co., Binghamton, N. Y.
Hammacher, Schlemmer & Co., New York.

TOYS, ELECTRICAL.

Carlisle & Finch, Cincinnati, O.
Davis & Sons, M., Salem, O.

TRUCKS.

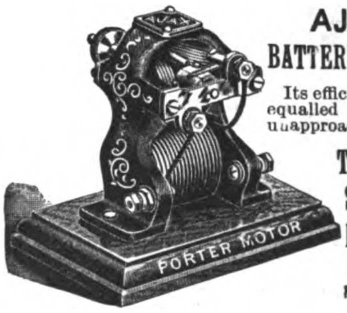
Peckham Truck Co., New York.

TRANSFORMERS.

Bibber-White Co., Boston, Mass.
Electric Appliance Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

TRAPS, STEAM.

Griffing, A. A., Iron Co., Jersey City, N. J.



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Its efficiency is unequalled and finish unapproached.
The Porter Standard Motor Co.
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Water Wheel Governors.

Sensitive enough to adjust gates for the slightest changes in speed and quick enough to take care of heavy changes of load, as required for Electric Lighting, Power and Railway Plants. Correspondence solicited.

The Replogle Governor Works,
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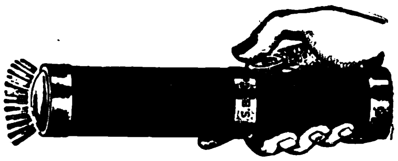
H-P Safety Pocket Light.



An ever-ready Electric Light for all purposes where a safe and handy flashlight is desired. Lights instantly. Cannot be blown out.

Gives from 6,000 to 8,000 lights before battery requires renewal. No wires to get out of order No chemicals to spill. Can be carried into a cellar full of leaking gas, into an oil tank, alcohol and malt vats, OR PLACED IN A KEG OF POWDER, without the slightest danger of explosion. Size, 9x1½. Weight about 1⅛ Lbs.
Price, Complete...$3 00 By Mail........ $3.30
Extra Battery..... .30 By Mail .... .50
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Sterling Varnish Co., Pittsburgh, Pa.

VENTILATING FANS.—(See Fans.)

VITOGEN.

Harvey Co., G. F., Saratoga Springs, N. Y.

VOLTMETERS AND AMMETERS.

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Cherry Electric Works, New York, N. Y.
Keystone Elec. Instrument Co., Phila.
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Lombard Water Wheel Gov. Co., Boston, Mass.
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Eastern Electric Cable Co., Boston, Mass.
Electric Appliance Co., Chicago, Ill.
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Okonite Co., Ltd., New York.
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Commutator Lubricant and Dressing.
Keeps commutator in perfect condition with the fine steel 'blue glaze engineers like so well.]
Sample free to Dynamo Engineers. | JOSEPH DIXON CRUCIBLE CO., JERSEY CITY, N. J.

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The Best Arc Lamp in the Market?

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FOR

The Upton "Midget," Enclosed Arc.
The Upton Lamp, Open Arc.

Made for All Circuits!
Absolutely Steady White Light!
No Parts to Wear or Get Out of Order!

ENCLOSED ARCS BURN 125 TO 150 HOURS AND TAKE 3 TO 6 AMPERES, AS DESIRED.

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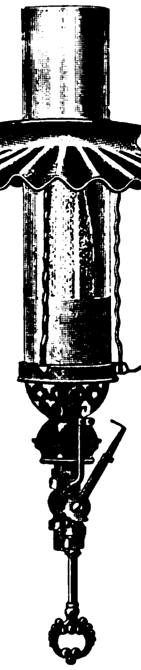
Can be successfully fitted to all styles of Incandescent Burners.

One turn of the key turns on and lights the gas.



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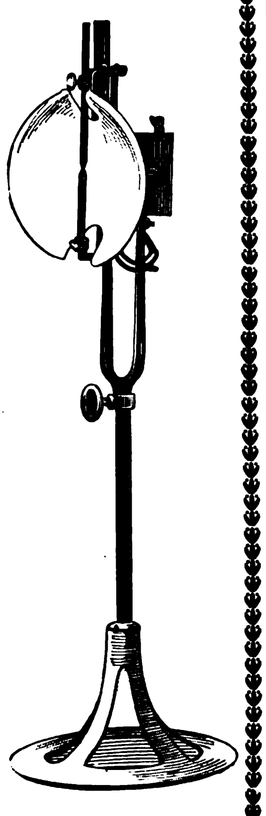

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Write for Circulars of our
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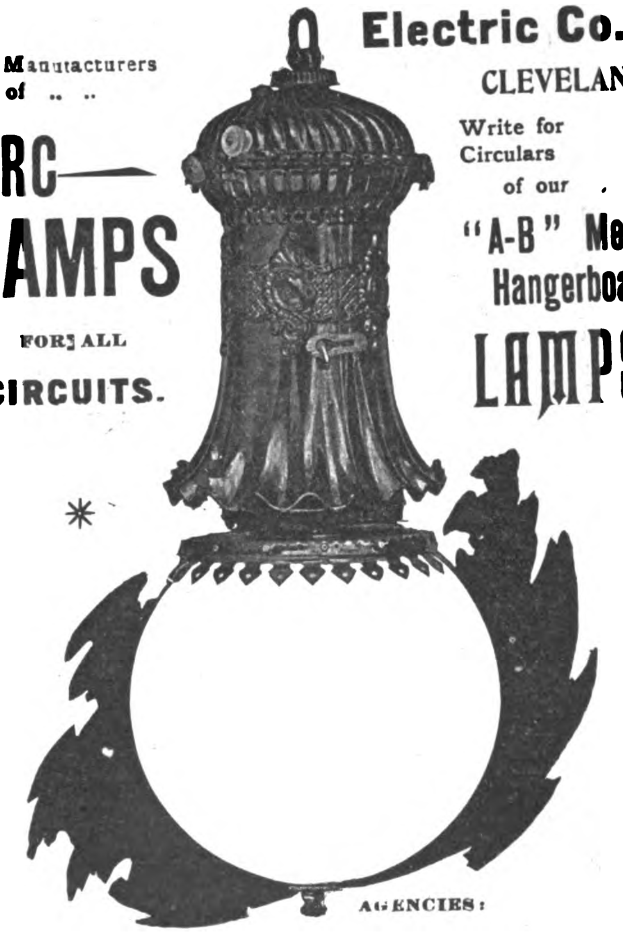

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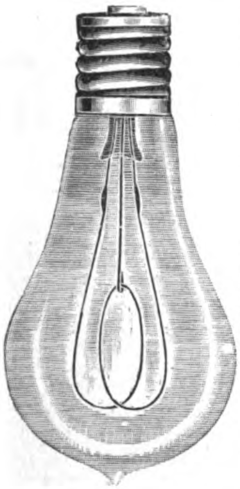

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Multiple, series for all circuits,
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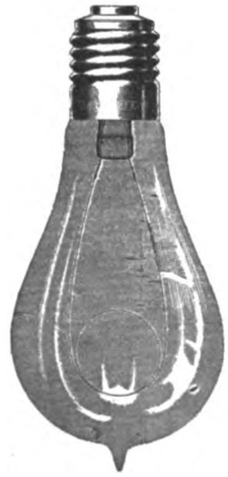

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KNOXVILLE, Tenn., Oct. 13, 1898.

Warren Electric & Specialty Co.,
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DEAR SIRS:—Your circulars and so forth received. We purchase our lamps from your company, but the fact is they burn so long I cannot send you an order very often.

One of your lamps burned for us on a post out doors, where we used it for lighting the yard, over two years. Our engineer claims it burned two years and six months.

I send you a name and will follow with an order when we need them.

Yours truly,
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Copy of letter received from
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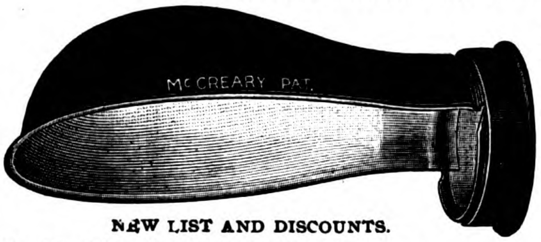
Glass, Aluminum, Tin.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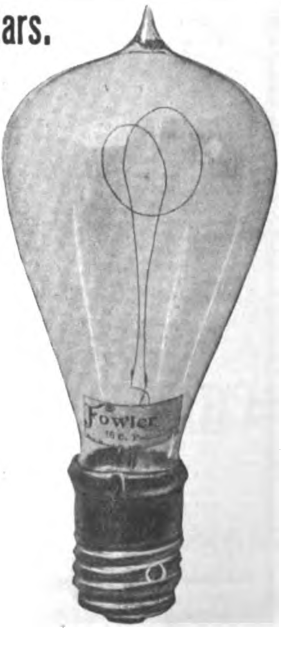

OURS is the only lamp made that is not "plastered together." We use no plaster whatever, but our specially shaped globe is securely held by a collar which fits over the bead on our globe, and inside of the base, and which is soldered fast, so that we have

A LAMP THAT
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- Will not soak up moisture to chew off the inleading wires.
- Is worth more after it is burned out, as base is not clogged up with plaster, but may be detached and used again.

QUALITY.—It is not possible, in a written description, to show the good qualities of our lamp for light giving, life and efficiency but we claim that our lamps will give longer average life, and maintain their candle power better than any other lamp using the same current, if used under the same conditions.

GIVE THEM A TRIAL.

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FOR ENCLOSED LONG-BURNING ARC LAMPS.

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FOR DIRECT CURRENT ARC-LAMPS

FOR ALTERNATING CURRENT ARC-LAMPS

HIGHEST GRADE NUERNBERG CARBONS

UNEQUALLED IN QUALITY AND EFFICIENCY

ABSOLUTELY STEADY AND BRILLIANT LIGHT.

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Notice. See that every package of my Carbons bears the label with my trade mark "Electra," thus. Beware of imitations. To protect the interests of purchasers of my Carbons, I am determined to proceed against infringers of my "Electra" trade mark.

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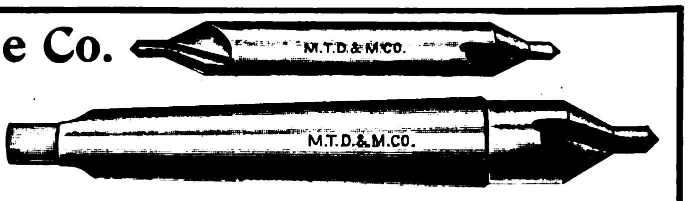
Drills, Chucks, Reamers, Cutters, Taps and Dies, and Machinists' Tools.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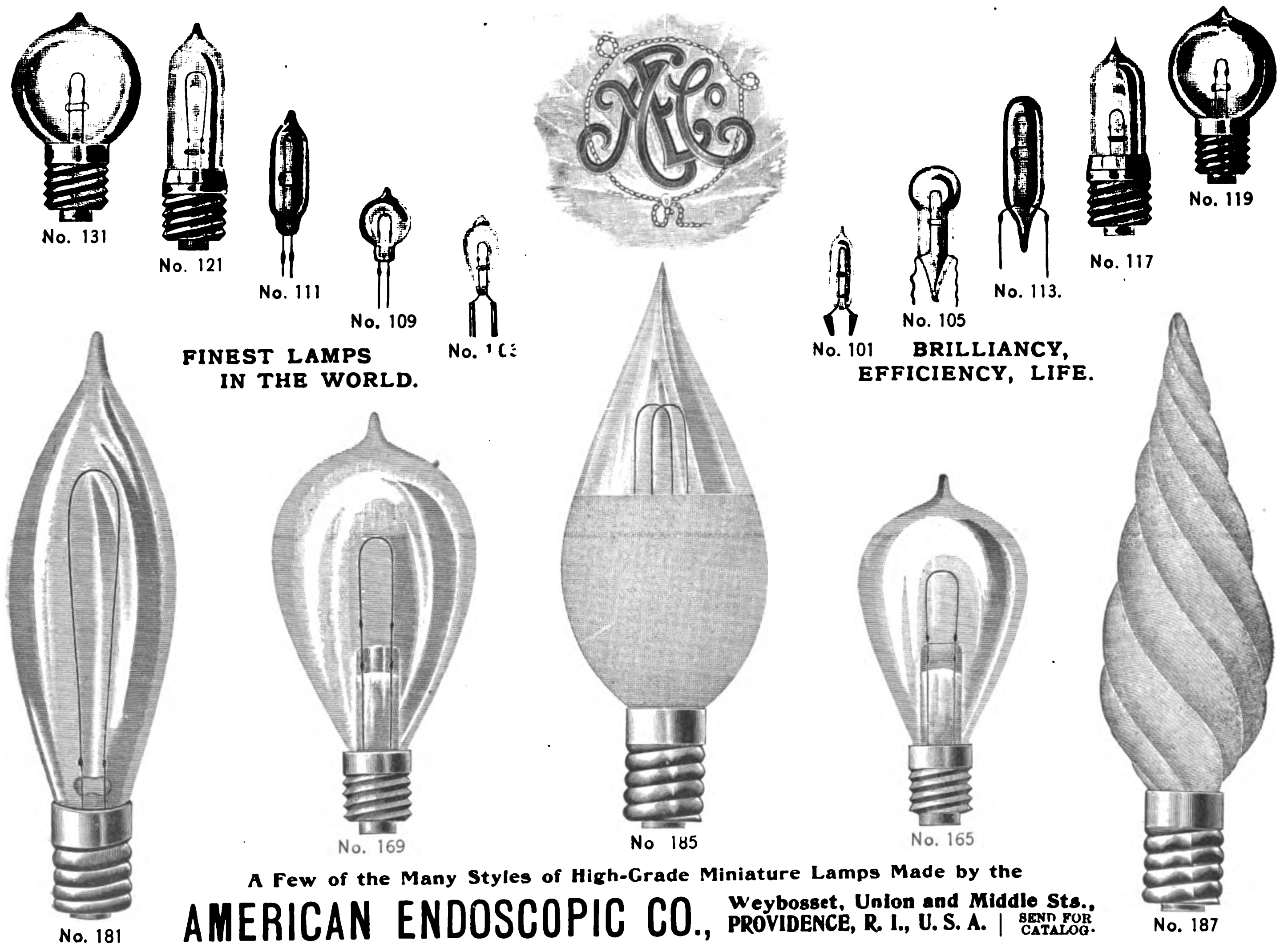
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BRILLIANCY, EFFICIENCY, LIFE.

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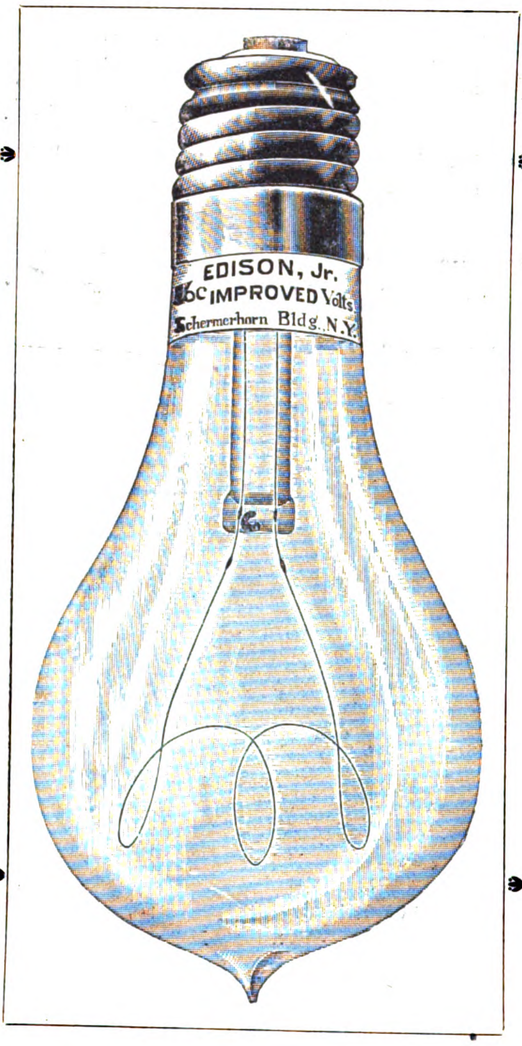
Incandescent Lamp.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IMPROVED Volts
Schermerhorn Bldg. N.Y.

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Concentrated, Brilliant White Light.
Carbons Never Become Red.
Standard Candle Power.

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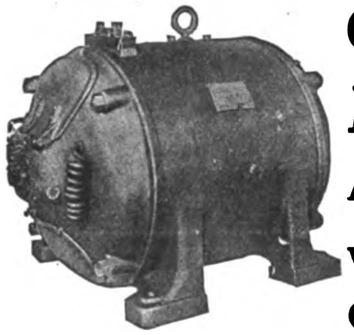

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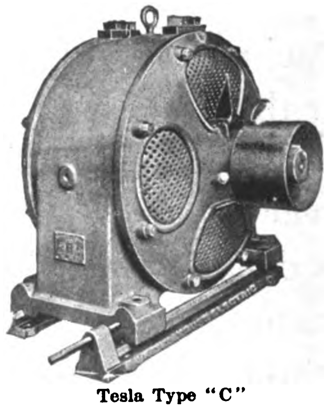

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Sawyer-Man Electric Co., Makers of Incandescent Lamps.

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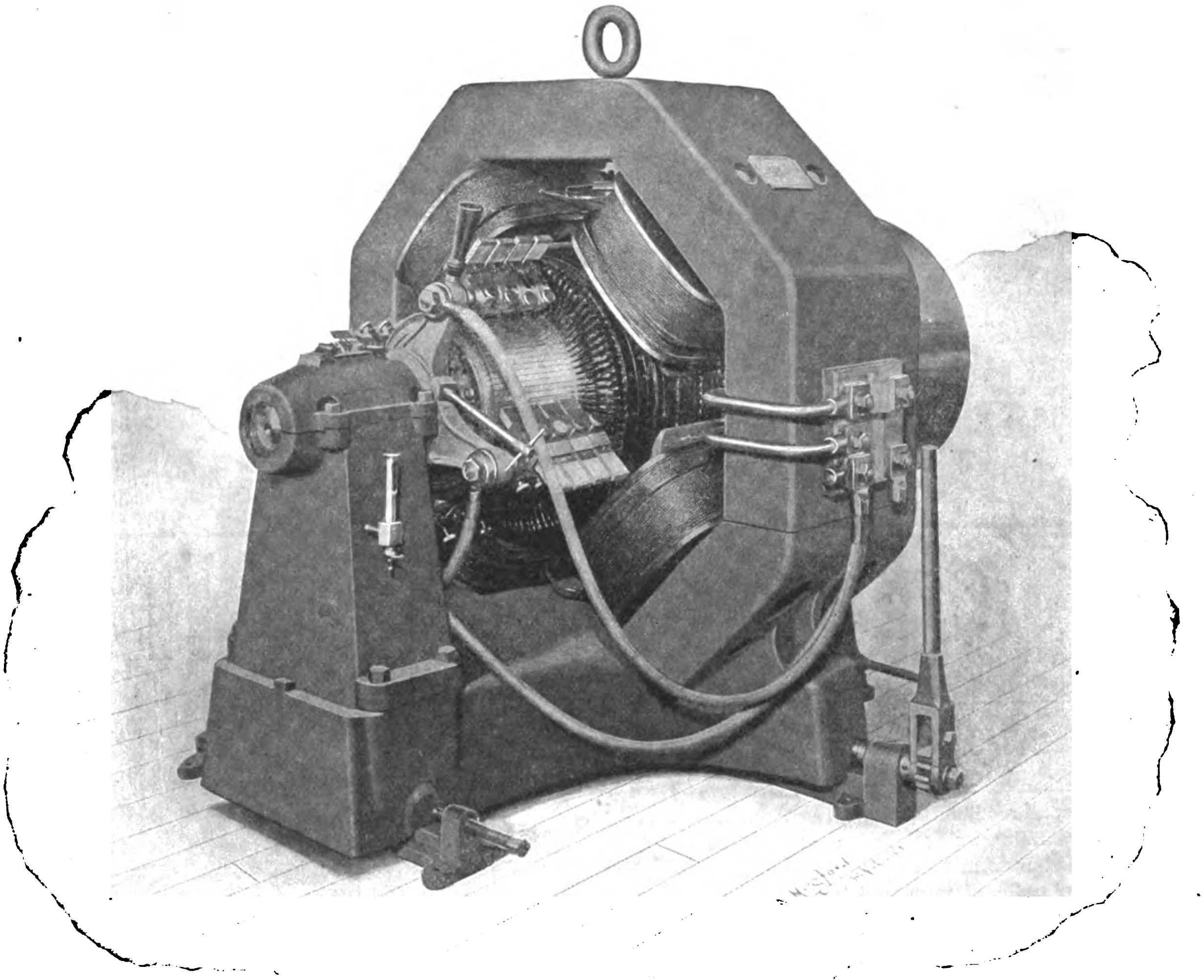

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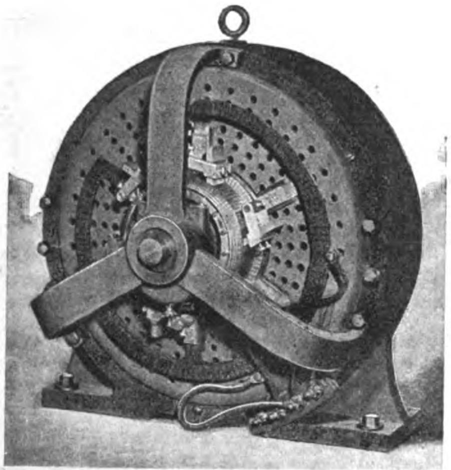

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For Direct Connection to all kinds of Machine Tools, Printing Presses, Line Shaftings, etc.

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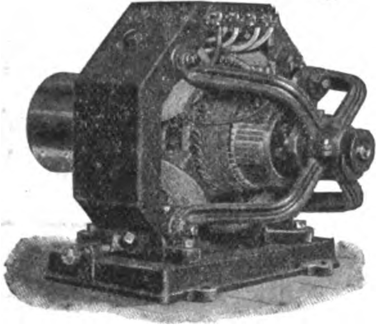
Multipolar and Bi-polar Dynamos and Motors.



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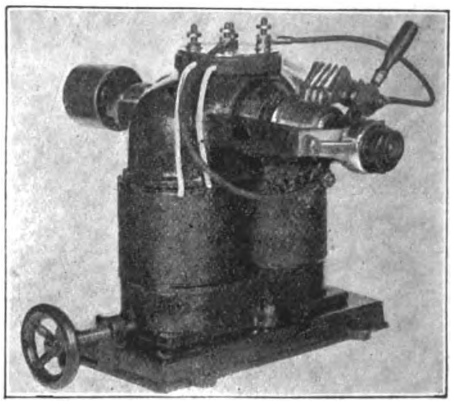
High Grade Machines at Lowest Prices.



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Multipolar Dynamos and Motors

Points of Superiority

Perfection of mechanical and electric details, insuring smooth running under all conditions and with a minimum of attendance ● Scientific electrical design, resulting in highest efficiency of transformation ● Operates without sparking and heating, and will withstand large overloads ● India mica insulation and highest grades of material employed throughout ● Winding done by expert mechanics ● Self-oiling bearings, always cool ● Every part easily accessible ● Every machine guaranteed for one year.

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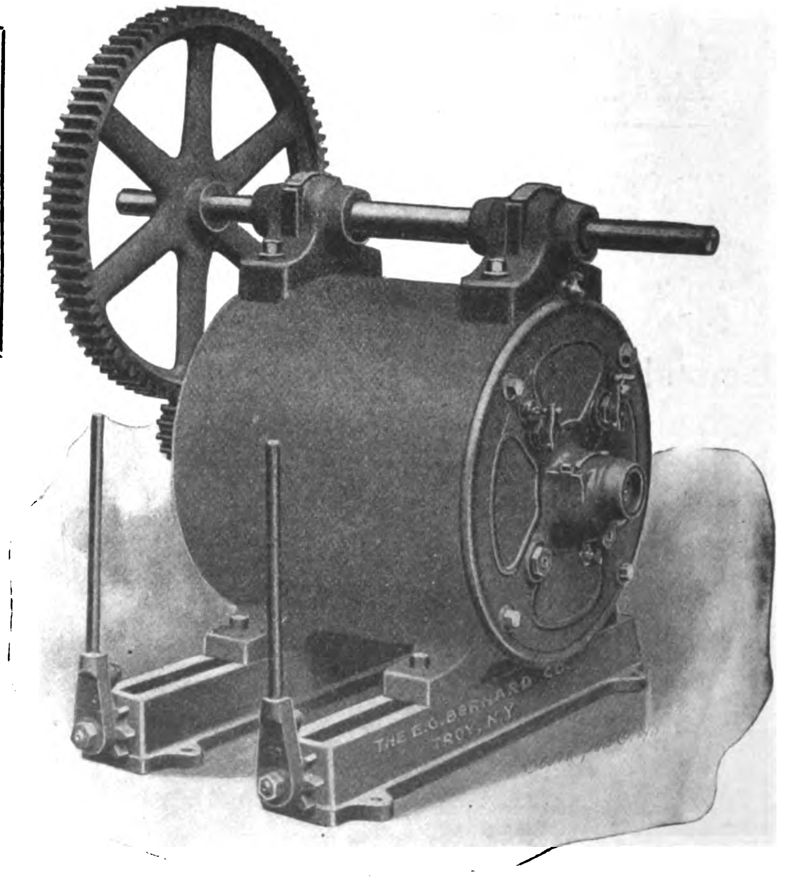

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These Machines embody the latest principles of Scientific Design and the Perfection of Mechanical Skill.

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SMALL GENERATING SETS

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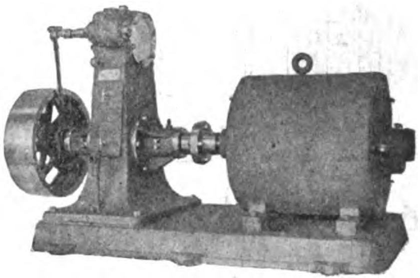

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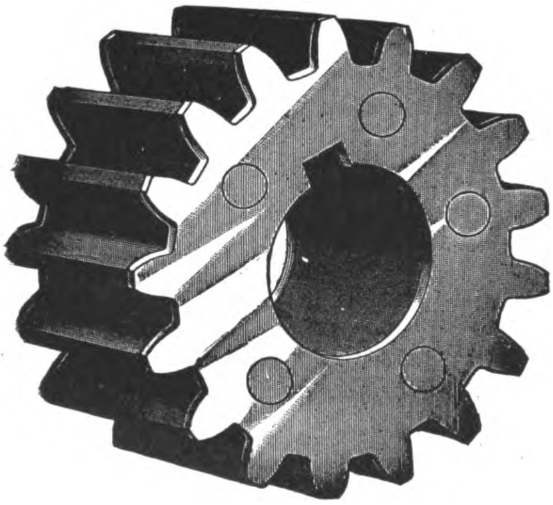

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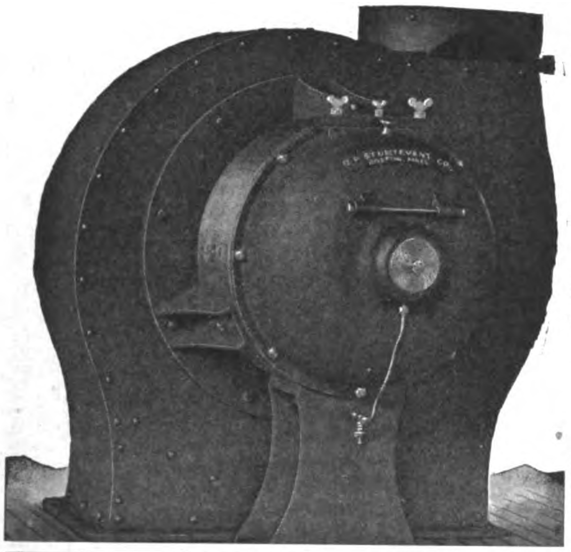

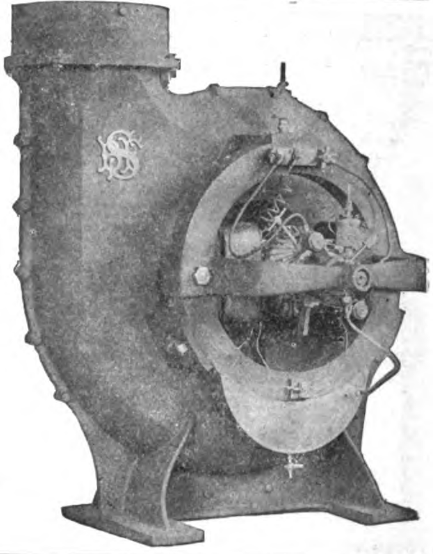

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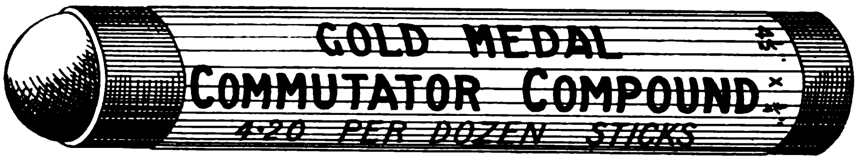

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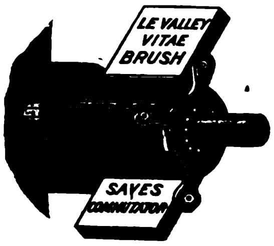

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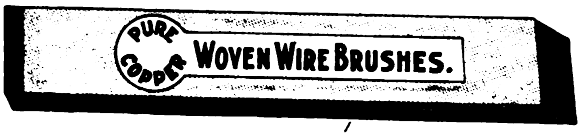

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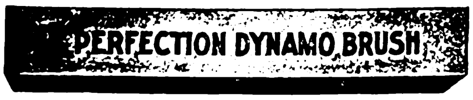

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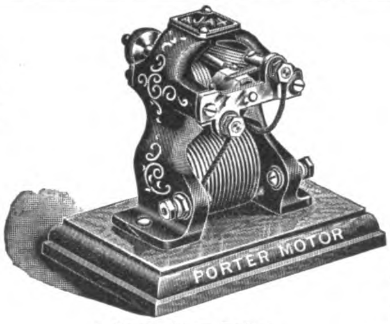

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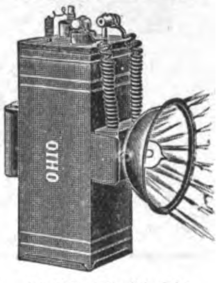

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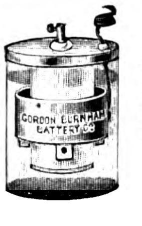

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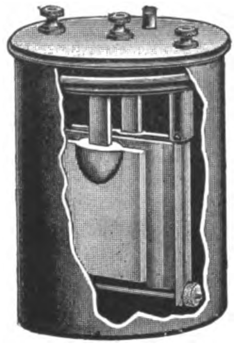

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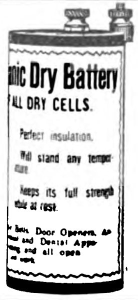
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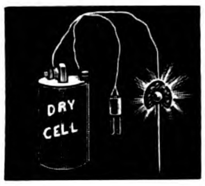

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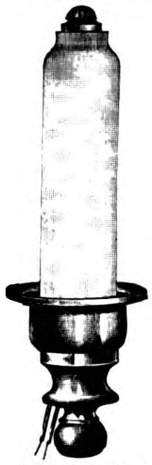

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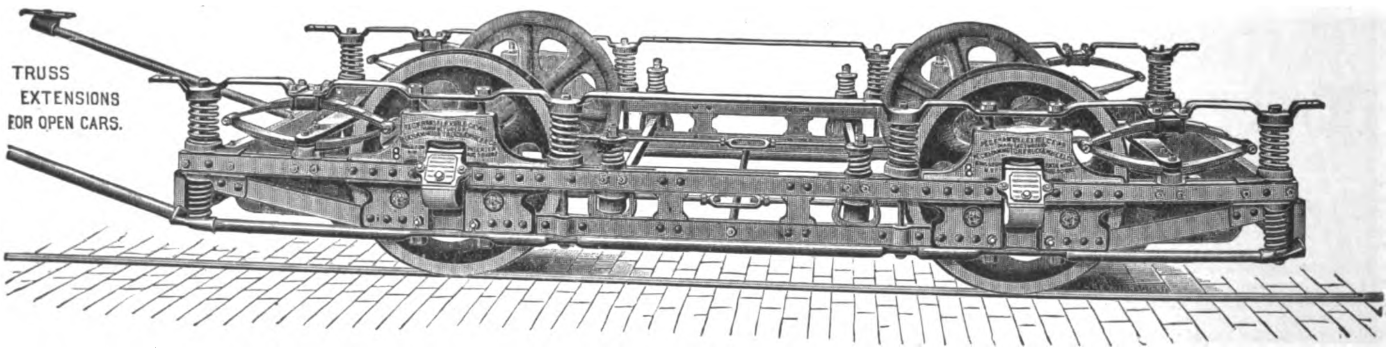
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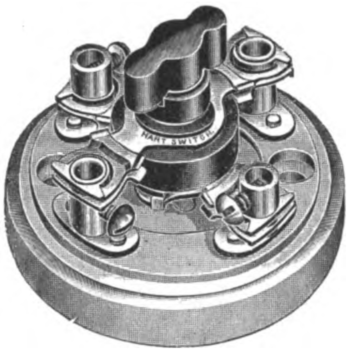

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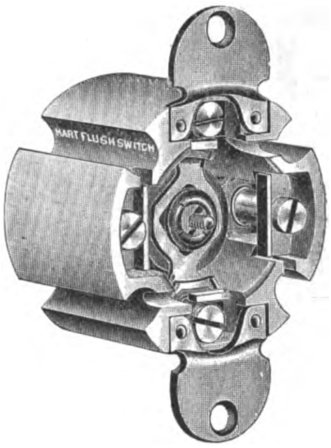

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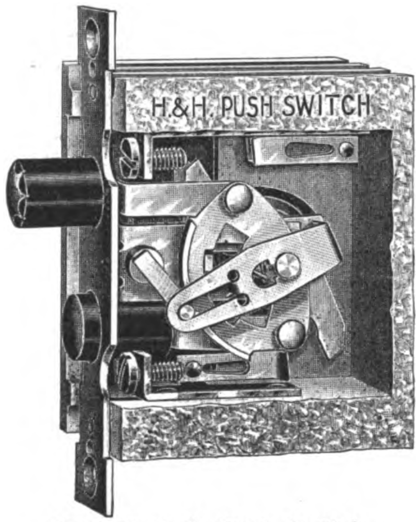

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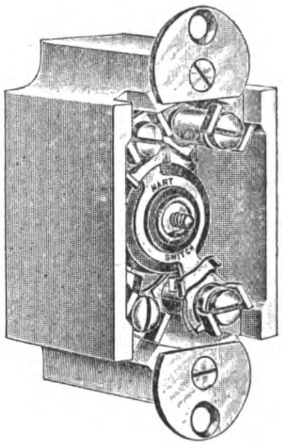

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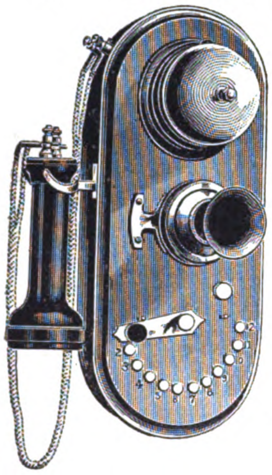

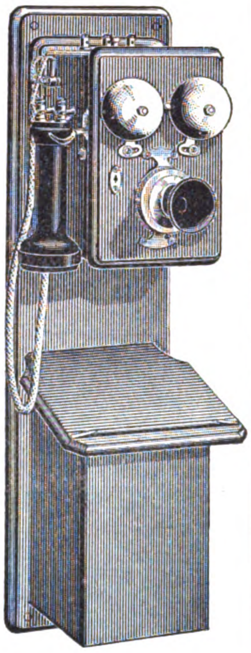

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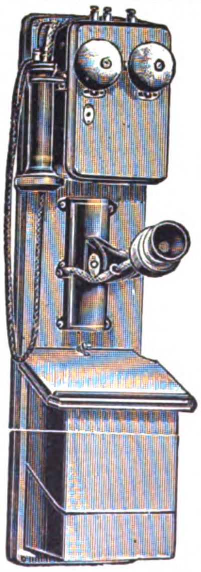

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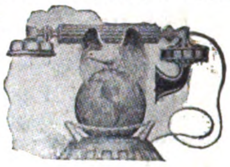

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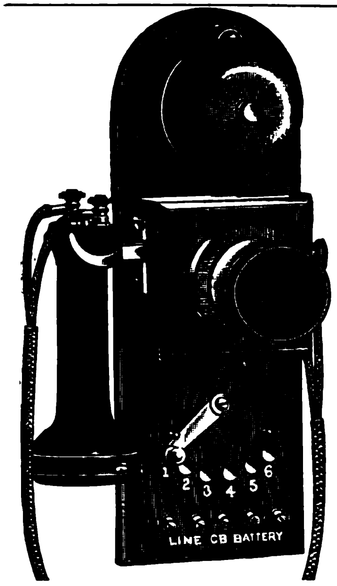

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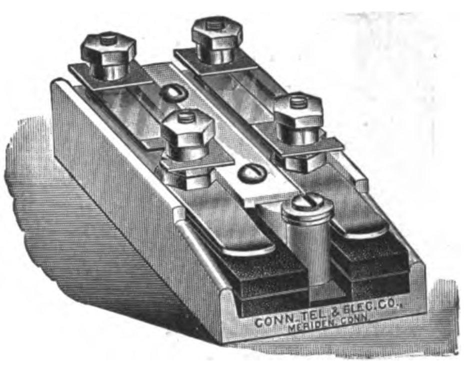
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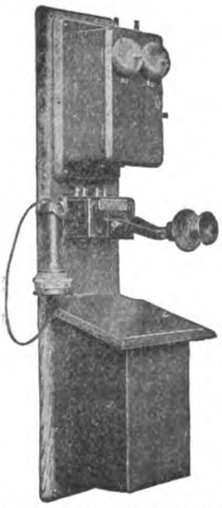

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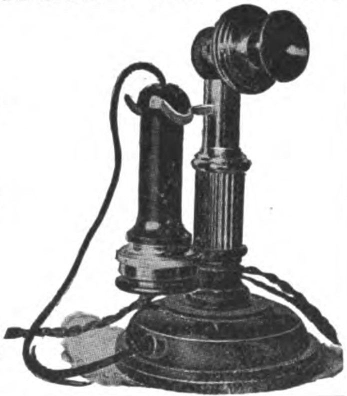

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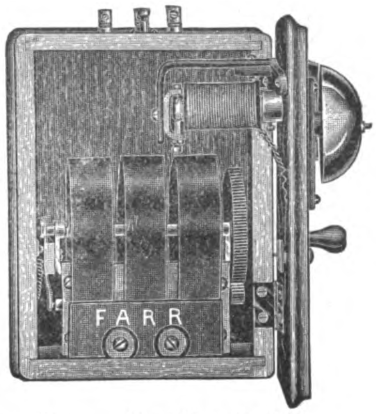

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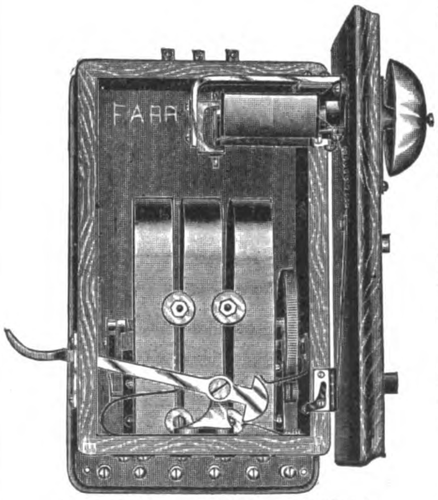

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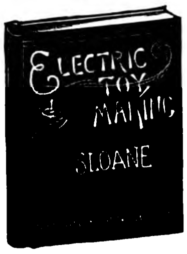

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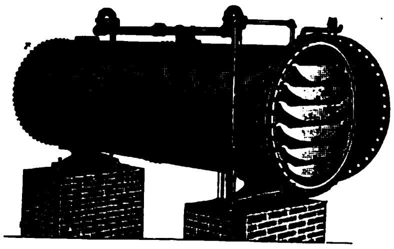

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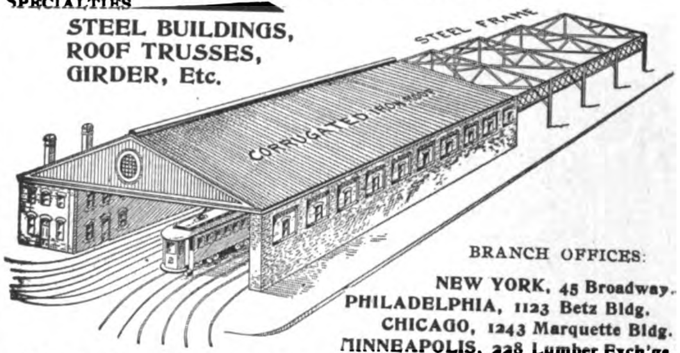
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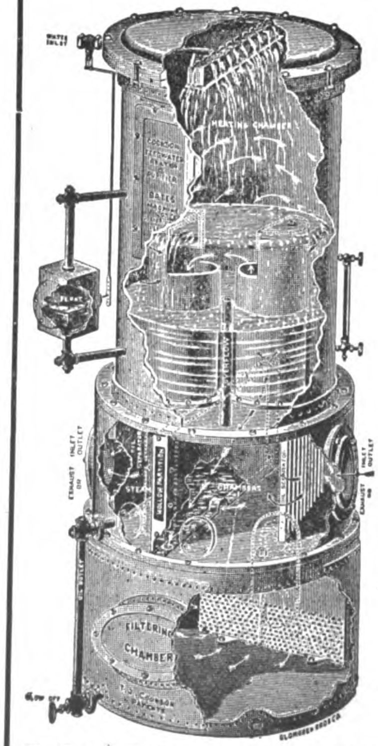
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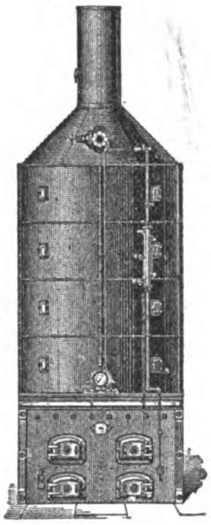

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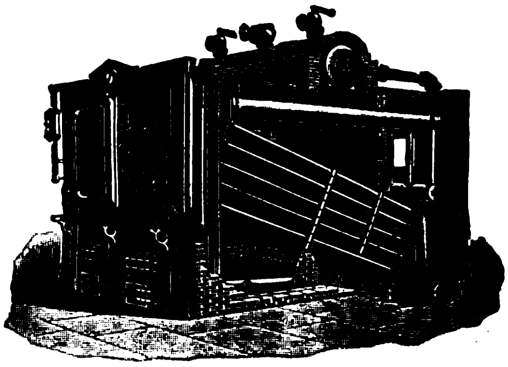

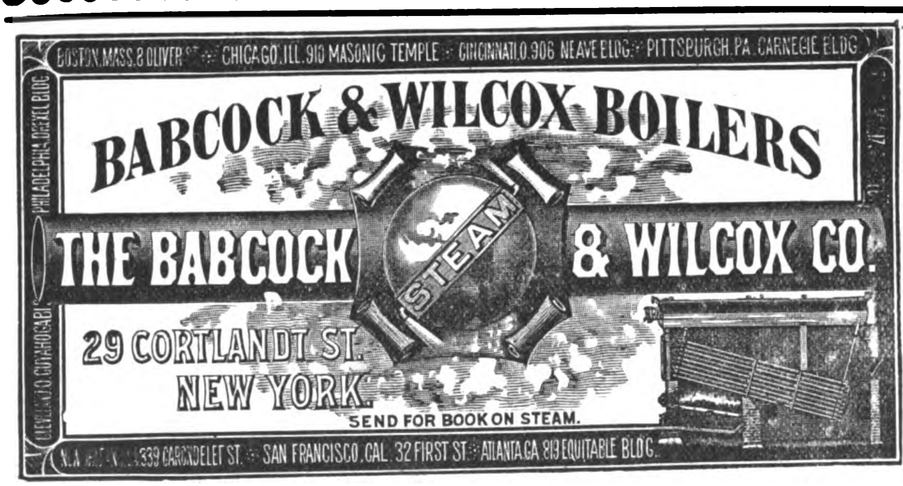

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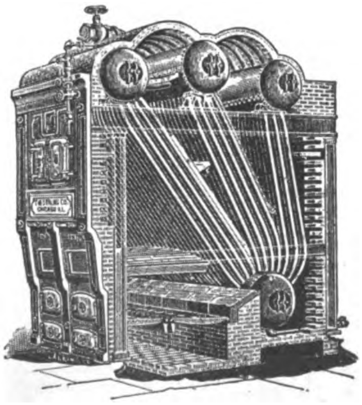

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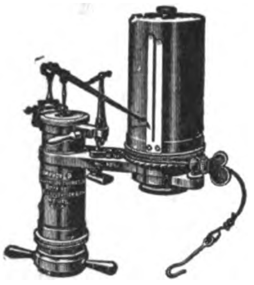

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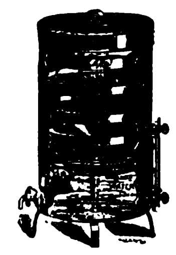

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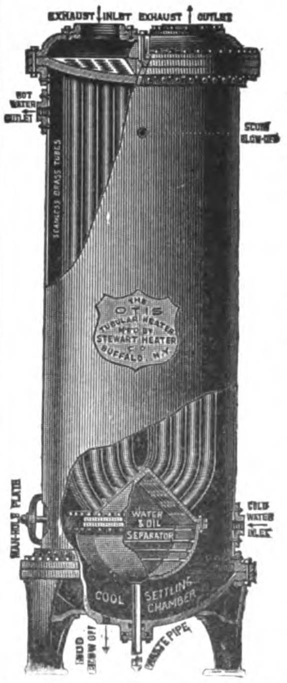

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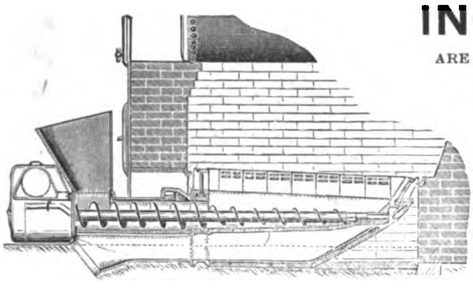

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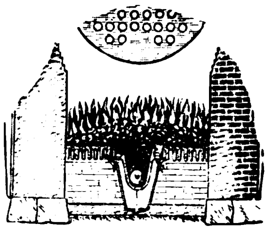

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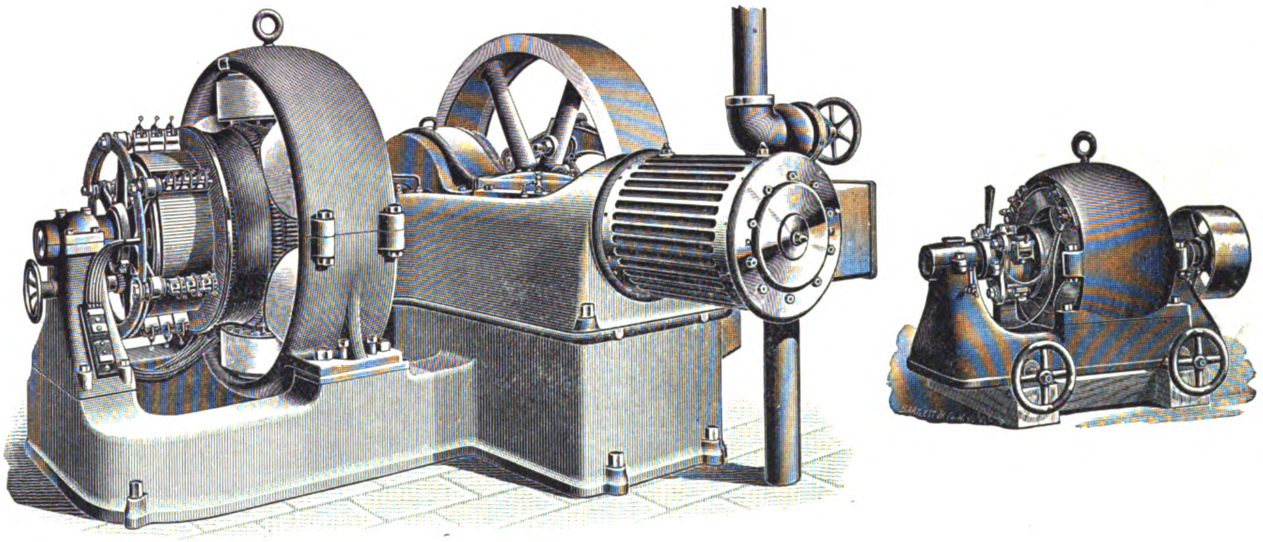

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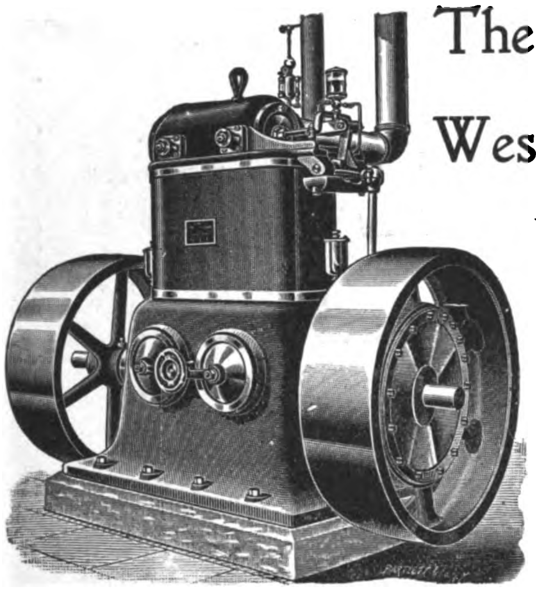

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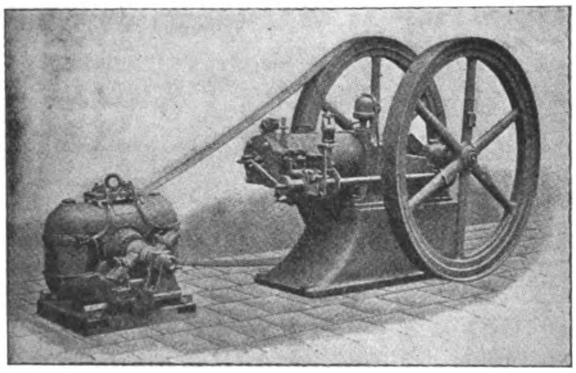

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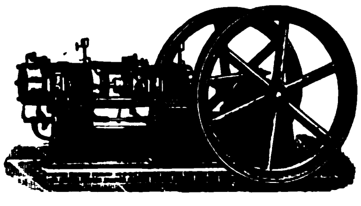

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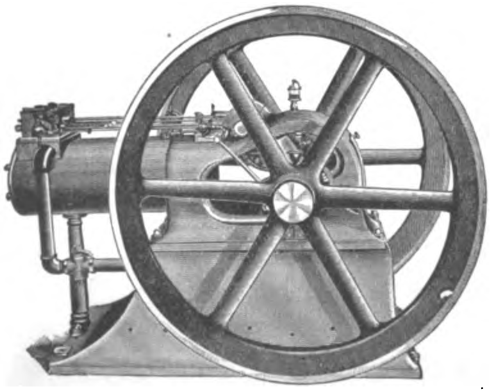

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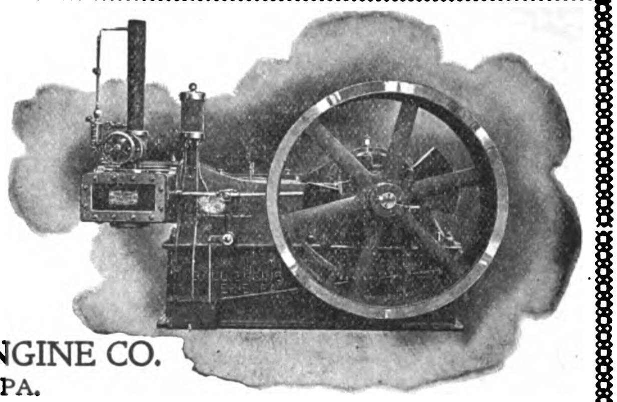

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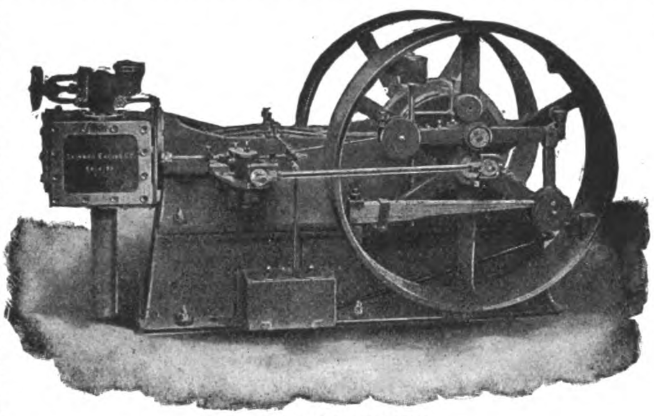

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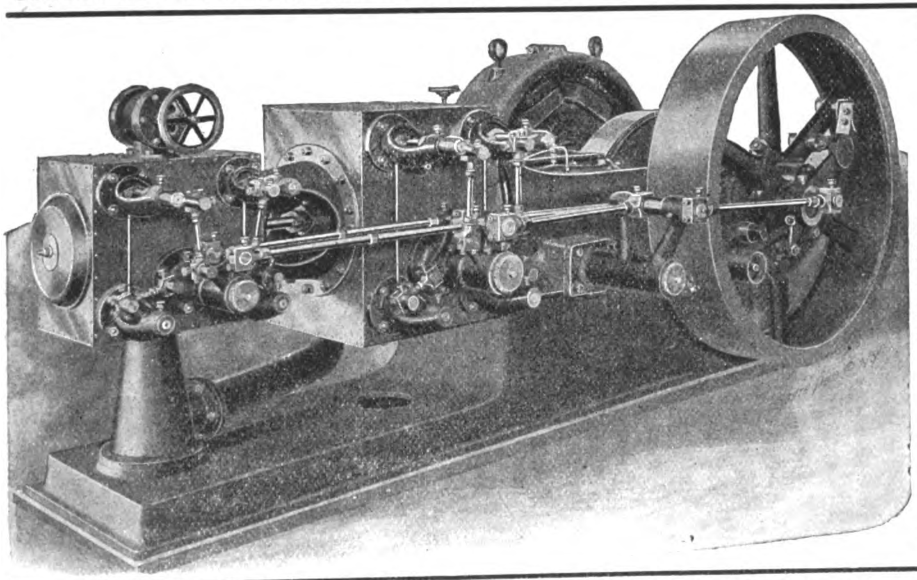

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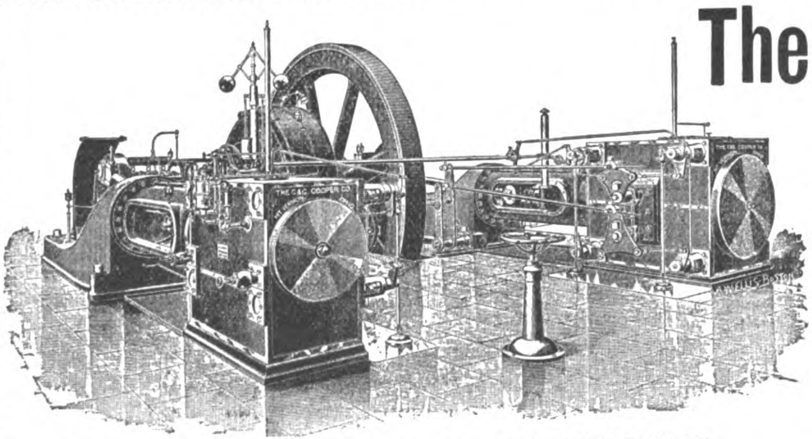

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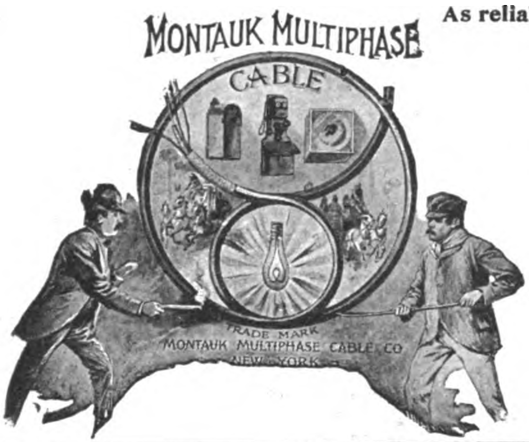

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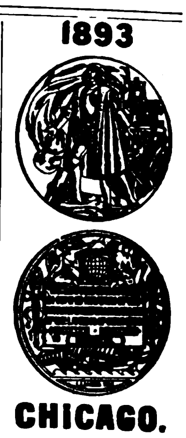

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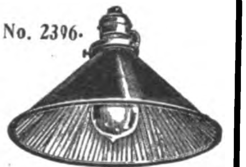

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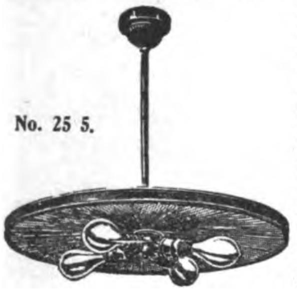

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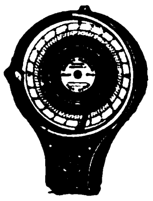

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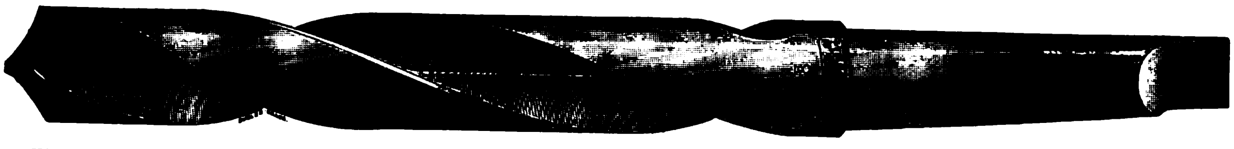

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